the Petroleum Engineer

FOR MANAGEMENT

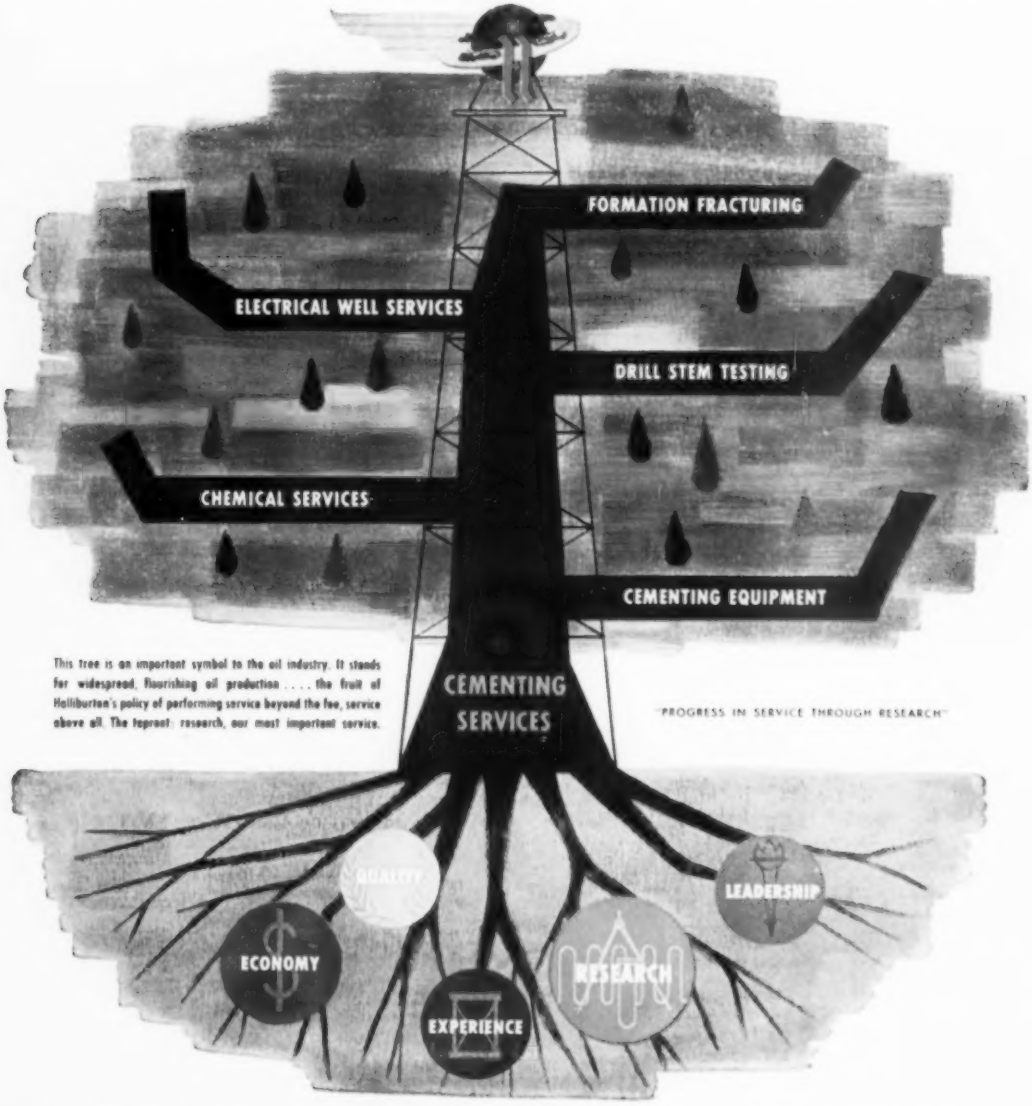
INTEGRATED EDITION OF THE PETROLEUM ENGINEER

What Management Says About Offshore Operations

Phillips Research Center

Source of Chemical Raw Materials — The Petroleum Industry

THE HALLIBURTON TREE OF SERVICE



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"PROGRESS IN SERVICE THROUGH RESEARCH"

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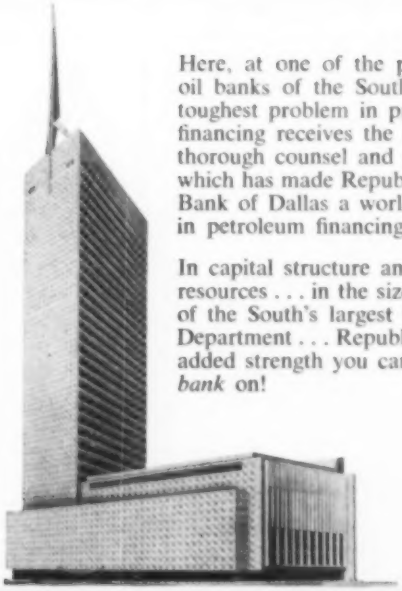

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— *Leonard E. Reed*

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The Slough of Price Control

IF you're an independent natural gas producer you are in a swamp of Federal controls with little help in sight. The legislation that was carefully woven to pull you to safer footing is being unravelled again.

Several groups — the producers, transmission line men and distributors —worked long and earnestly to put together the Harris-O'Hara bills, which made Federal controls slightly more bearable. Then at the beginning of the hearings proposals were made by the Administration that would throw producers right back in the quagmire of red tape and confusion.

The whole sequence of events is a strange and somewhat ominous tale. It illustrates so well the thin protection we have against determined men who would control the market places of the nation from Washington.

The Natural Gas Act of 1938 stated that its regulations did not apply "to the production or gathering of natural gas." After 16 years of following the obvious meaning, the Phillips decision of the U. S. Supreme Court had the effect of revising the law — of putting independent producers under utility-type pricing like that of interstate pipelines.

Congress twice passed laws exempting producers from the Supreme Court's surprising interpretation. The first one was vetoed by Truman; the second by Eisenhower.

Now Congress is asked to approve what was virtually the Supreme Court's 1954 version of the Natural Gas Act. The majority of Congress was persistent in its adherence to freedom from Federal controls for gas producers. But the determination of those favoring Federal power in this — and other areas — is phenomenal. It's like fighting an enveloping fog.

Once in, you never quite leave the slough of Federal controls, as U. S. farmers can testify. They are so deeply involved with Federal controls now that the only way out is to give up farming, and many of them have — forced out by rigid, unrealistic regulations. Taxpayers have been assessed billions for subsidies and then as consumers they have paid more in higher costs for food. Has anybody won?

Only one result would pay for the costly confusion of 25 years of crop control — if we and our political representatives both learned the basic lesson that prices are not made in Washington.

Of course, crop control is designed to give producers more money; natural gas control is set up to give producers as little money as possible. Crop control is to favor the farmers and gas control is to favor consumers.

Our prediction is that the latter will be as successful as the former. In the last five years net farm income dropped 23 percent despite billions in tax money poured into the program.

As for natural gas, not only will higher costs and inflation be reflected in the prices set by FPC but there is strong indication that short supply will exert a still heavier pressure.

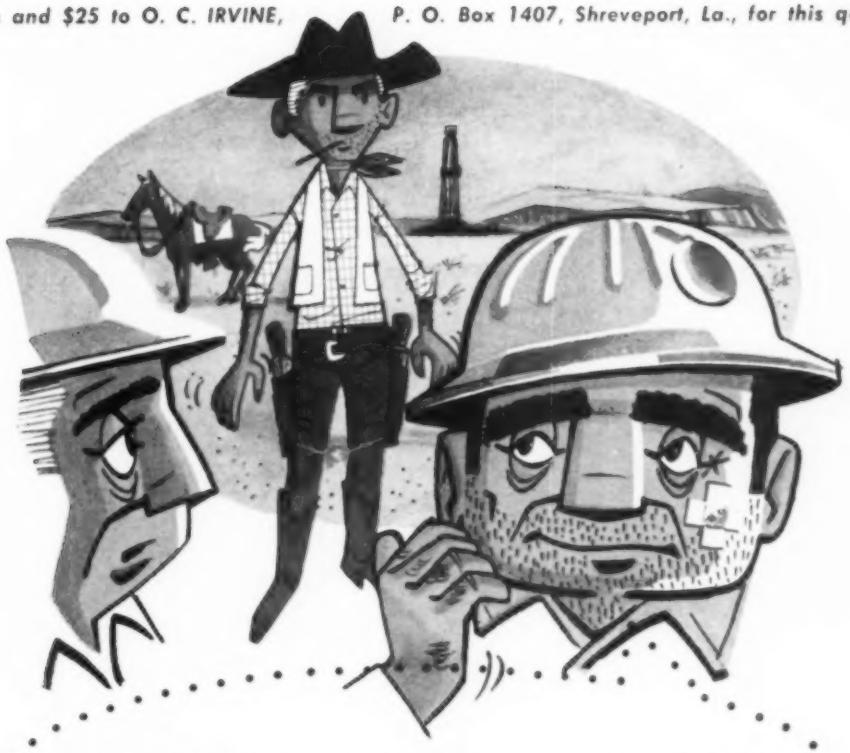
In the three years since gas producers have been under FPC control only one new interstate carrier has been certified. Commitments of natural gas to present big interstate carriers have fallen off alarmingly.

Any underpricing would simply cut supply as surely as overpricing of farm crops has brought consistent oversupply. The function of price works even when set artificially: Higher prices increase supply; lower prices bring smaller supplies. In the long term price control is unfair to the consumer.

These are things we know. It shouldn't take much soul-searching to realize, too, that it is unfair to cater to a segment of the consuming public for temporary advantage by plunging the entire gas producing industry into the morass of Federal price control. It is one first we wouldn't want on our record — the first peacetime price control of a freely competing industry.

Ernestine Adams

Congrats and $25 to O. C. IRVINE, P. O. Box 1407, Shreveport, La., for this quip.



"Sez he's good at perforatin'!"

Oil industry authorities forecast more wells and more footage as the year progresses . . . over 59,296 new wells are expected in response to spiraling demands for oil.

Lone Star Steel is completely attuned to this new tempo . . . and is rushing construction of a new open hearth furnace and stretch-reducing mill. Eventually, Lone Star will produce more fine steel . . . and more fully-normalized API casing, tubing and line pipe for our friend and neighbor, Joe Roughneck, heart of the oil and gas industry. Depend on Lone Star . . . because Lone Star is on the grow!

Neighbor, wherever you are, specify Lone Star and we both get a good deal.

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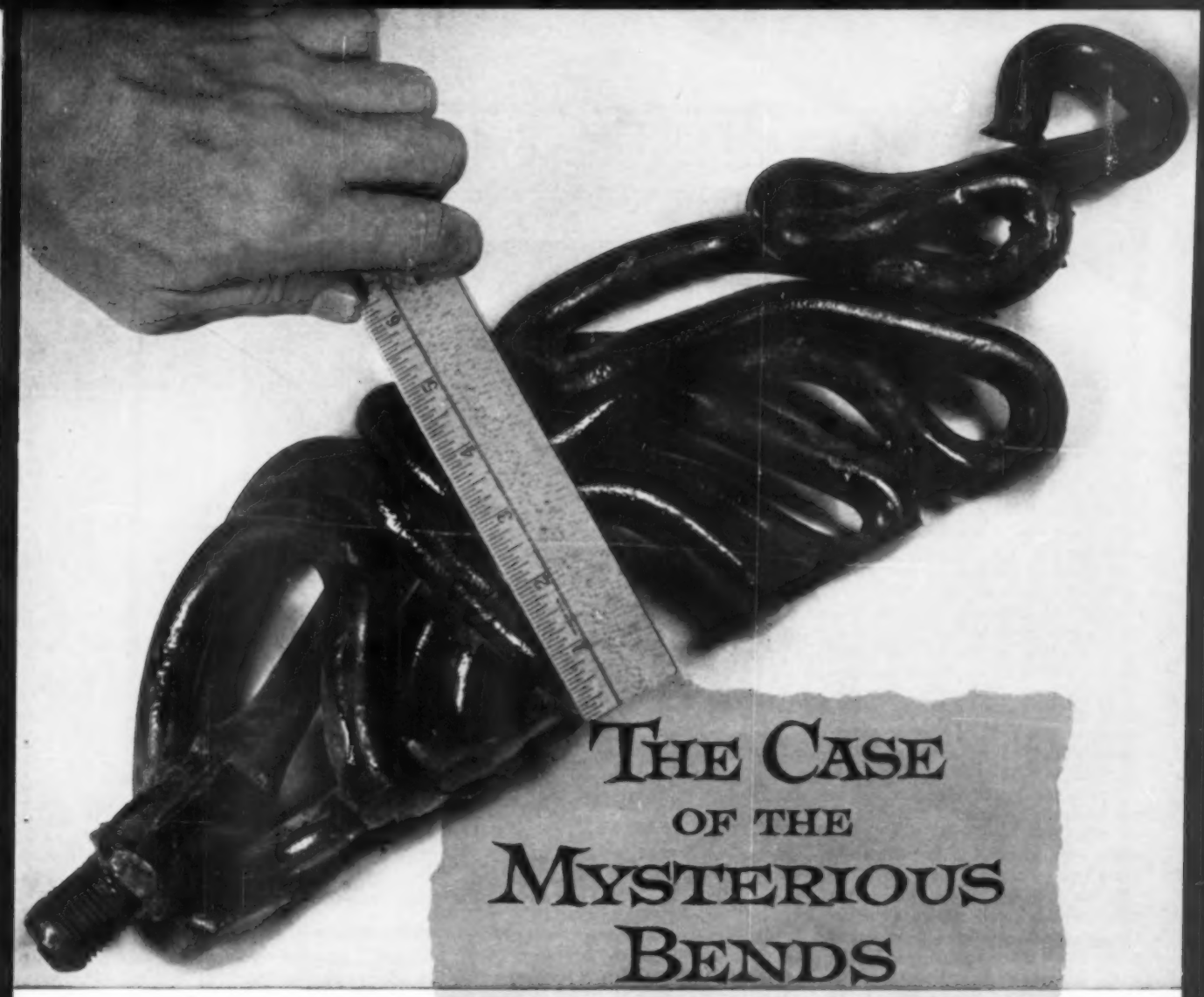

THE CASE OF THE MYSTERIOUS BENDS

IT HAPPENED NEAR CAPROCK, New Mexico. The well quit pumping. Neither the 9000 ft. string of sucker rods nor the tubing could be pulled. What had gone wrong?

The long task of "fishing" and a "work-over" got under way. The casing had collapsed in two places. Two joints of tubing had split . . . and from one of these split sections they removed the exhibit shown above.

Fourteen feet of ¾" sucker rods had been compressed into *eighteen inches.*

Have you ever seen a sucker rod so twisted and bent? Like ribbon candy! *Yet the rod didn't break!* (Rod partings shown in the picture were caused by a diamond core bit that milled over the rod during its removal.)

Frankly, it's hard to believe that a sucker rod could be ductile and tough enough to take such terrific bends without fracturing. This phenomena is as surprising as it is mysterious.

The rod is one of ours . . . an "Oilwell" Grade "W"* . . . and it's fully heat-treated to combine high strength with high ductility . . . the kind of rod you can really depend on.

***GRADE "W" is one of our strongest rods . . . recommended for heavy duty in non-corrosive wells and for sulphide service.**

Complete Heat-Treatment of sucker rods, including LIQUID QUENCHING AND TEMPERING, is a process that is exclusive with "Oilwell." It includes extra production steps that bring out all the advantages of the alloys in the steel. Three of the five "Oilwell" sucker rod grades receive this complete treatment . . . to give you stronger, safer, longer lasting rods. Yet, they cost no more than competitive grades.

Write or ask for a free copy of our Sucker Rod Comparison Chart.

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USS TRADE MARK

"OILWELL" TRADE MARK

UNITED STATES STEEL

Petroleum Profile

IT sounded like a lot of money—$1.50 a day. So W. C. (Bill) Whaley signed up to work in Coalingo, California, for the Commercial Oil Company, the same company his father worked for.

That was 1910, and Whaley was 16 years old.

Today, he is president of Sunray Mid-Continent Oil Company, a fully integrated oil company with headquarters in Tulsa, Oklahoma.

Although the other roustabouts were making $3 a day, Whaley's father hired his son for half that amount because he didn't want him to have the "big head" about making "big" money.

It was good training for the youngster, for anyone who knows him today can tell you he'll never have the "big head" about anything.

As president of Sunray Mid-Continent he directs the overall exploration and production activities of the company as well as the hundreds of administrative details of Sunray, which operates in 23 states and several foreign countries.

Apparently the 12-hour day that he put in during his first few years in the industry became habit because he still works long hours after more than 40 years in the industry.

When he thought he had learned the fundamentals of oilfield work, he decided to see what his new talent would bring from other companies. In the next 12 years, excluding two years in the army during World War I, he worked in the oil fields of California, Wyoming, Oklahoma, Texas, Montana, Kentucky, and the British West Indies.

In 1924 he joined the former Barnsdall Oil Company as a driller. By 1931 he was named a vice president for that company. From this position he moved quickly up the ladder. In 1940 he was made a director of the company and he became general manager of the firm's California operations in 1941.

When Barnsdall merged with Sunray Oil Corporation in 1950, Whaley became a Sunray director and vice president. He was elected president of Sunray in 1952, the position he now holds.

His formula for success, his friends say, has always been the same — an intense desire to learn.

From that first day in a California oil patch, he hasn't stopped asking questions, trying to learn something new about his work.

He says he was fortunate to be around men who knew the answers and would stop to explain the intricacies of the business—especially petroleum engineers, for whom he has a notably high regard.

W. C. WHALEY

President,

Sunray Mid-Continent Oil Company

Whaley still thinks the oil industry is the best in the world for young men with ambition. He says few industries take time today to show a real interest in the young men, to develop the young men's ability.

Throughout his career in the oil business he has felt that the human relations have been the most important aspects of growth, development and eventual success.

"You have to know people and be able to evaluate them quickly and still be accurate," he says. "There are many men who can fill the same job, who have the same working ability, but their interest and desire make the big difference."

Whaley's respect for ability and his modesty of his own success is apparent in his dislike of two words used everyday in business.

He doesn't like to call people who work for him "employees" and he doesn't like to be called an "executive."

"We're all working here for one company," he says, "and each of us has a job to do. The important thing is to get the work done as best we can . . . and that includes all of us. Whether we're an 'employee' or 'executive' makes no difference."

Although he has more than 40 years' experience in the oil business, he still finds it interesting and challenging. The quick pace of progress has kept him out of a "president's rut," he says.

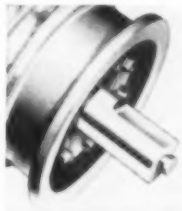
He travels often to the company-operated field units. He's at home in the lease foreman's one-room office or in the conservative executive offices on the 13th floor of the Sunray Building in Tulsa.

His advice to youngsters today?

"Above all, be sincere with yourself. If you are, you'll find the career you want and you'll go after it with a growing interest in the future."

The Whaleys have two sons. Robert Lee is studying medicine at McGill University in Montreal and John Patrick is a law student at Stanford University.

They look forward to vacations when they can hunt and fish with their father.



"500" means up to 500 work hours between lubrications from new CAT* rollers. Add up the savings in service time and labor costs this feature gives you! Available for Caterpillar D7, D8 and D9 Tractors, the Cat "500" Roller also features large load carrying bearings, deep hardened *forged steel* rims, selectively hardened shafts and special long-lasting seals. Other makes of rollers may look like originals, but can you trust them? Be sure to get parts you *know*—from your Caterpillar Dealer.

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THE CONFERENCE TABLE

"One cannot upgrade self while downgrading others" — LEONARD E. READ

The Bill Nobody Loves

At a press conference in Biloxi, Mississippi, Congressman Oren Harris, who introduced the new bill to regulate natural gas producers, made it clear that unless he had the wholehearted support of the gas industry for his bill he would make no effort to get it on the floor or to get it passed.

His own coolness toward the bill was repeated by IPAA, which agreed to support the bill as a whole, but individual members exhibited apparent indifference or active disagreement. The meeting of representatives of state associations could not agree to support the bill. TIPRO, for instance, said it could give its support only with a number of amendments.

It was not until the administration proposed a couple of amendments which would virtually have put a seal of approval on the present utility-type regulations that some members of the oil industry began to warm up to the Harris-O'Hara Bill. But so far it has not generated any devoted support from any section. Nobody thinks it's quite worth fighting for.

Lowdown on Management Courses

Have you been following the series on executive development courses offered by universities and colleges? The fourth one of this series can be found on Page E-17. It describes a four-week program of Ohio State University in Columbus.

So many oil companies are interested in these courses that we decided to give all the information we could about the programs. If you haven't the first three of the series we'll be glad to send you copies of them. Write Management Editor, The Petroleum Engineer, Box 1589, Dallas, Texas.

What Readers Write

"In reading your interesting article, '11th Annual Report Survey,' I noticed in Table 3 an estimate of reserves. As I did not find estimates of these reserves in the 1956 Annual Report, I am curious to know the source of the estimates given in your article." *R. A. Fowler.*

We omitted a footnote, which should have been in this table to explain reserves. For companies whose reserves were not given in the annual reports we used a publication of last year "Officially Reported Oil and Natural Gas Reserves" published by Merrill Lynch, Pierce, Fenner, and Beane. When companies ask that reports given in this folder not be released we deleted them. Some companies do not, of course, make evaluation reports each year on their reserves. The figures are not entirely uniform. Some companies give gross; others give net reserves. Some include payments to be made in crude oil; others exclude these. Some keep secondary recovery projects production separate from primary recovery reserves.

Communications Book Still Popular

The book "A Common Sense Approach to Better Communications," by Dr. Dennis Murphy, continues to draw attention. It is in its third reprinting and now orders are coming from many outside the petroleum industry.

The communications book is a reprint of a series of articles in *The Petroleum Engineer*, and makes an excellent text for employee training. Several companies have ordered hundreds of books for this purpose.

Industry Provides Raw Materials

If you are like a great majority of the people in the oil industry you're not too sure of how the petroleum and chemical industries help each other. In this issue Dr. William E. Kuhn and John W. Hutcheson have written a simple, easy-to-read article on the petroleum industry as a source of chemical raw materials (Page E-3).

One thing we liked in this article was that the authors chose to emphasize the petroleum *industry* rather than just petroleum as a source of chemical raw materials. It is the petroleum industry, they say, which has prospected discovered, drilled, and produced petroleum from which basic hydrocarbons are obtained. The industry has been able to make products available in adequate supply without seasonal fluctuations. Prices have been kept low enough to encourage their use in chemical manufacturing with the added benefit of proved price stability.

You will find the article well worth reading, full of information without bogging you down in hard-to-understand detail.

The Freeman's Free

One small but very valuable publication called *The Freeman* is available without charge to anyone who is interested in receiving the publication. It is published by Foundation for Economic Education, Inc., Irvington-on-Hudson, New York. It is a pocketbook size magazine devoted to "ideas on liberty." If you have never seen a copy we suggest you write for one and see if you want to be put on the subscription list.

Leonard E. Read, whom we quote in today's Conference Table, is president of the Foundation for Economic Education.

Earnings Climb Steeply

Earnings are running 18 percent higher than last year according to first quarter financial reports of 54 companies. In spite of this high increase it is still less than last year's rise over 1955 of 20 percent in the first quarter. Revenues rose 16 percent for 50 companies in the same period.

What brought about record earnings? The reasons are discussed by several companies.

According to J. C. Donnell II, president, Ohio Oil Company's highest first quarter earnings in 70 years of operations were due primarily to increases in production and prices of crude oil.

Shell Oil Company's president, H. S. M. Burns, attributed the quarterly improvement to increase in sales and other operating revenue and to betterment in net crude oil production. He stated, however, that it was not anticipated that the company's record level of production could be maintained for the balance of the year.

J. R. Parten, president, said Woodley Petroleum's sharp

increase in earnings resulted from increased allowables, new wells, and higher crude prices.

Standard of California was able to improve its earnings position in the first quarter despite an abrupt drop in returns from Eastern Hemisphere affiliates and higher operating costs in the far west. Board Chairman R. G. Follis said that Western Hemisphere results had shown a substantial upturn and that improved earnings there had more than offset the reduced income resulting when production in Saudi Arabia fell off to two-thirds of the previous rate. He pointed out that the company was only maintaining its ratio of earnings to investment and emphasized that the inflationary spiral has decreased the value of the dollar, accelerating multiplication of earnings.

Improvement in earnings for The Texas Company came principally from increased production in the U. S. to supply Europe during the Suez disruption, reported Augustus C. Long, board chairman. He did not anticipate, however, the percentage increase would be maintained in other quarters of this year.

Board Chairman W. Alton Jones, of Cities Service Company, said that record financial results of the first three months were due in part to large capital expenditures in recent years, which are just now becoming productive, and in part to improved tanker rates during the first quarter.

"Among other factors responsible for improved first-quarter results" said Chairman Robert E. Wilson of Standard Oil of Indiana, "were a general price increase for crude oil, followed by upward adjustments in product prices. These afford a measure of price relief, long overdue. However, some of these product prices have already weakened again."

Not every company, of course, showed increases. Various reasons were given for this situation.

R. S. Macmillan, of Macmillan Petroleum Corporation, said their net loss, compared to a profit of the same period in 1956, was due in part to increased marketing expenses brought about by an accelerated sales campaign and additional advertising expenditures. Another contributing factor to the decline was that crude oil prices were substantially increased and the increase was not immediately offset by higher product prices in the first quarter when past commitments were fulfilled.

Company President William Wallace Mein, Jr., attributed Bishop Oil Company's decrease in gross income to severe reduction of allowables in the Pembina oil field of Alberta Province, Canada.

Emory T. Clark, president, Clark Oil and Refining Corporation, also felt that failure of refined product prices to reflect promptly the increased cost of crude oil and other increased operating costs was a factor in decline of earnings in the face of increased sales. He also mentioned a comparatively warm winter and extremely competitive conditions in both wholesale and retail markets.

Howard C. Pyle, president of Monterey Oil Company, pointed out that their accounting system was one reason for the company's showing. Monterey does not include amounts applied to liquidate reserved oil payments in determining gross cash or net income. If reserved oil payments had been included, an acceptable alternative method of accounting, net income for the two six month periods under review would have been increased.

Foreign companies came in with good 1956 reports over 1955.

Reported the last of April was British Petroleum Company's net profit of $148 million, up 11 percent from 1955.

Shell Transport and Trading Company, holding company of a Royal Dutch-Shell Group, showed an increase of 24 percent in net income. Royal Dutch-Shell Group of companies reported a net income for 1956 of $504 million compared with $448 million in 1955, an increase of 12 percent.

ALL RECORDS TOPPLE

54 Companies Earned
$978,799,000 . . . . . up 18%
50 Companies' Revenues
$6,286,126,000 . . . . . up 16%

INCOME FOR FIRST QUARTER, 1957

Company	Gross Income $1000 1957	Gross Income $1000 1956	% of 1956	Net Income $1000 1957	Net Income $1000 1956	% of 1956
Amerada	32,790	28,894	113	8,746	7,623	115
American Petrofina	11,420	—	—	877	—	—
Anderson Prichard	17,706	15,917	111	1,484	1,353	110
Argo Oil	3,793	3,200	119	1,680	1,232	136
Ashland O & R	80,091	66,747	120	4,919	3,550	134
Atlantic Ref.	169,646	148,486	114	14,761	12,223	121
Bishop Oil	695	720	97	102	119	86
Champlin O & R	20,793	18,695	111	3,107	2,346	132
Cities Service	306,489	267,032	115	23,427	18,180	129
Clark O & R	22,241	19,023	117	472	735	64
Colorado O & G	7,755	6,877	113	690	533	129
Continental Oil	154,455	144,635	107	13,640	13,794	99
Cosden Petroleum	18,721	13,992	134	1,544	1,104	140
Crescent Corp.	—	—	—	—	303	—
Fifteen Oil Co.[1]	2,438	1,775	137	1,005	842	119
General American	6,849	6,032	114	2,530	2,349[2]	108
Gulf Oil	—	—	—	94,938	71,963	132
Hancock	15,310	14,287	107	1,961	2,936	67
Honolulu Oil	11,911	10,495	113	3,844	3,749	103
Humble O & R[10]	—	—	—	58,200	49,300	118
Husky Oil[3]	15,908	14,540	109	844	1,321	64
Kerr-McGee[4]	48,091	42,218	114	2,713	2,040	133
Louisiana Ld. & Exp.	9,378	6,727	139	5,491	3,605	152
Macmillan	508	371	137	(9)	60	—
Maracaibo	612[5]	559	109	163[5]	144	113
Midwest Oil	4,961	3,921	126	2,102	1,788	117
Monterey[1]	9,851	9,339	105	725	705	103
Ohio Oil	78,513	73,021	108	12,666	11,771	108
Phillips Petroleum	296,104	258,879	114	28,379	28,332	100
Plymouth Oil	31,961	27,040	118	2,519	2,283	110
Pure Oil	134,207	127,708	105	10,170	9,184	111
Quaker State	13,900	14,102	99	370	525	70
Richfield	69,644	61,797	113	7,039	7,512	94
Seaboard	13,665	11,763	116	3,393	2,663	127
Shamrock[3]	14,594	12,386	118	2,616	2,617	100
Shell Oil	469,178	405,341	116	41,450	35,010	118
Signal O & G	6,396	5,579	115	3,176	2,443	130
Sinclair Oil	348,296	316,650	110	26,302	24,246	108
Skelly Oil	68,725	63,375	108	11,388	8,033	140
Socony Mobil	—	—	—	70,000	62,000	113
Standard Calif.	432,112	360,993	120	69,473	61,494	113
Standard Ind.	555,568	486,153	114	45,851	41,378	111
Standard N. J.	2,043,000	1,730,000	118	237,000	205,000	116
Standard Ohio	111,585	96,717	115	7,841	6,517	120
Sun Oil	208,424	173,927	111	13,331	12,255	109
Sunray Mid-Con.	95,154	81,674	117	16,297	11,385	139
Superior Oil[3]	25,626	20,941	122	4,335	1,047	414
Texas Co.	—	—	—	86,424	69,958	124
Texas Gulf Producing	4,754	4,288	111	1,879	1,583	119
Texas Pacific C & O.	6,595	6,138	107	2,068	2,055	101
Tidewater Oil	157,235	131,744	119	11,335	9,037	125
Union of Calif.	107,759	93,344	115	9,327	7,030	133
Union O & G of La.	8,693	7,076	123	1,711	1,236	138
Universal Consol.	1,736	1,556	112	981	898	109
White Eagle	5,603	5,717	98	418	272	154
Wilcox Oil	2,764	2,711	102	254	300	85
Woodley Petroleum	1,923	1,397	138	850	502	169
TOTALS	6,286,126	5,426,499	116	978,799	832,563	118

Unless specified first quarter ends March 31.
( ) loss
[1]For 6 months ending February 28.
[2]For 3 months ending November 30.
[3]For 6 months ending December 31.
[4]Excluding $408,106 non-recurring capital gain.
[5]For year ending December 31.
[6]Gross operating income.
[7]Excludes $831,649 non-receiving capital gain.
[8]For 3 months ending February 28.
[9]Excluding from totals 88⅔ of stock owned by Jersey Standard.

HIGHLIGHTS ★ ★ ★

Digest of News and Comment

"Production Facilities for Military and Atomic Energy Commission Procurement" is the government's new program to take the place of the defunct rapid write-off program. It is stipulated that some oil facilities can probably qualify under this heading even though the oil programs themselves have been closed down. Spur pipelines to serve military bases and strategic areas, and oil tanker construction had been given a boost under the old program. Both of these projects have been closed.

★ ★ ★

Efforts of segments of the Rhode Island legislature to create a petroleum control board has failed. The bill, under consideration by a state committee, would have empowered the group to regulate the distribution and sale of petroleum products and set maximum and minimum prices.

★ ★ ★

U. S. tanker expansion goal of 100 ocean-going vessels has been filled, Office of Defense Mobilization has announced. The goal, established in 1952, gave a fast tax write-off as incentive for expansion of the tanker fleet. The write-offs have been stopped. Of the 100 tankers in the goal, 45 have been built, and the rest are under construction or have been contracted for without tax write-off aid.

★ ★ ★

Kerr-McGee Oil Industries, Inc., is acquiring Triangle Refineries, Inc., of Houston, Texas. Triangle will continue to operate under its name as a subsidiary of Kerr-McGee. All officers of the company will continue in the same positions. One of the largest independent marketers of refined products, Triangle operates in 15 states; it has 11 pipeline, river and deep-water terminals in the Midwest and South. It markets the entire output of some 13 refineries and processing plants from Wisconsin to Florida.

★ ★ ★

Compulsory blending of grain alcohol with gasoline — as a means to end a grain surplus—has been rejected as "impracticable" by the President's Commission on Increased Industrial Use of Agricultural Products. Study cited that: A 10 percent blend (minimum effective amount) would require more than two billion bushels of grain annually — more than the surplus; plant to process this quantity would cost $2 billion in government funds; program would cost motorists another $1 to $2 billion annually through increased fuel prices, and added that it doubted grain's worth as a gasoline blending agent, anyway.

★ ★ ★

National Safety Council's 1956 Public Interest Award has been made to eight oil companies — Clark Oil & Refining Corporation, Esso Standard, Hedges Oil Company, Phillips Petroleum, Sinclair Refining, Shell, Standard of Indiana, and also to the Ethyl Corporation. The eight have contributed time and space in several advertising media for the promotion of accident prevention.

★ ★ ★

A to Z corporate story of the Shell Companies — and the contributions of the oil industry — is to be told in an ambitious two-year advertising program being undertaken by the entire Shell family. A series of two page advertisements will use the alphabet to tell its story, with each ad based around a different letter. First ad features A — for agriculture, accelerator, airplane, aldrin, antiseptic, etc.

★ ★ ★

Navy's oil shale research program will soon get action by Congress. New legislation calls for $10,000,000 to be spent over the next five years. Current obstacle involves whether or not Navy is to use Bureau of Mines personnel in all research and demonstration work or employ outside contractors.

★ ★ ★

Russia is widening its application of nuclear research to petroleum exploration and refining, the Moscow News and Pravda report. One source is quoted as saying that "the scattered gamma radiation method has been used extensively to study oil and gas deposits without core taking." Another recent release states that the atom is being used in petroleum refining in the USSR.

★ ★ ★

An indication of speed in getting gas price adjustments from the FPC is observed by watching the seven-year-old Phillips Petroleum Company case. In recent testimony the company indicated a need for a 12 percent return of its natural gas sales to assure it a reasonable profit and financing for future exploration. Its study showed that its 1956 "fair return" was $37,700,000 less than required on the basis of a cost-of-service investment of $84,900,000.

Awards for contributions to highway safety have been given to Esso Standard, Sinclair and Hedges Oil Company of Albuquerque, New Mexico. The awards are given by the Alfred P. Sloan Foundation in the field of radio and television.

★ ★ ★

"We'd better stop washing our dirty linen in public, or the wise guys in Washington will starting insisting we send it all to the government laundry," said Barney Majewski, president of the Great American Oil Company, Chicago, in his inspiring address to the IPAA the last of April. He warned that in our industry if one segment suffers, all suffer.

★ ★ ★

"Little Inch" pipeline conversion from natural gas to products, as sought by Texas Eastern Transmission Corporation, would drop midwest gasoline prices, company officials of the line contend. Price cuts would be the effect of increased competition with barge lines hauling petroleum. Texas Eastern would build a parallel line to carry the natural gas. FPC is hearing the case to convert the Texas to West Virginia line.

★ ★ ★

Shell has received the Department of Defense Reserve award for "outstanding cooperation" to the Reservists and Reserve activities. Rear Admiral Milton E. Miles, who made the award to company officials, said Shell has frequently given assistance and advice to the Armed Forces in petroleum research and pointed out that company facilities have been available for Naval Reserve use.

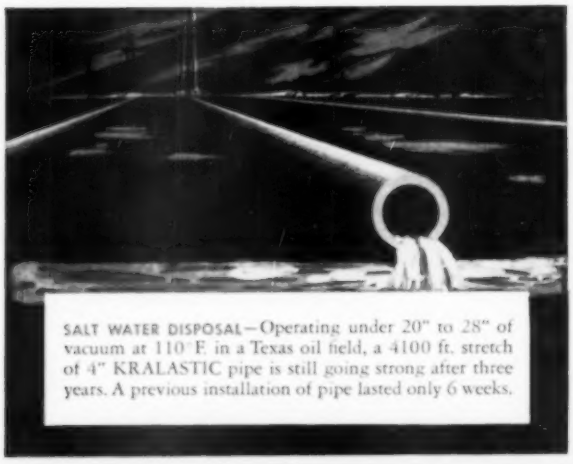
★ ★ ★

Oil-to-Europe program, which died a natural death on April 10, resulted in the sending of 82,600,000 bbl of Gulf Coast oil to Europe after November 1. Slightly more than half the total amount was crude. According to reports of shippers to the Department of Interior, an average of 354,000 bbl of Gulf Coast oil was exported to Europe in the final week of the emergency program.

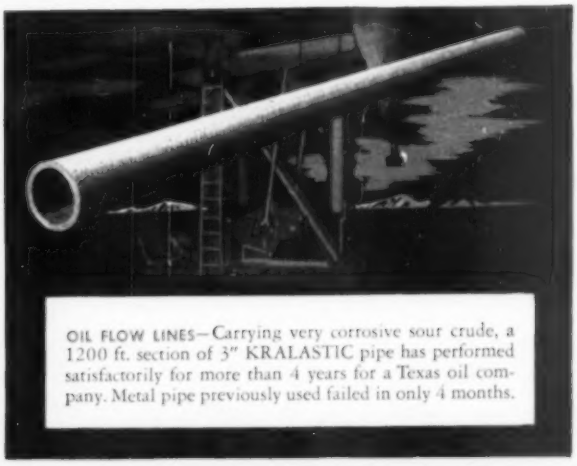
★ ★ ★

Tidewater Oil Company headquarters building is now under construction in San Francisco, California. Company is to build a $10,000,000, six-story structure with three basements for parking, with provisions for later expansion to 12 or more stories. Building will house headquarters offices and some western division offices.

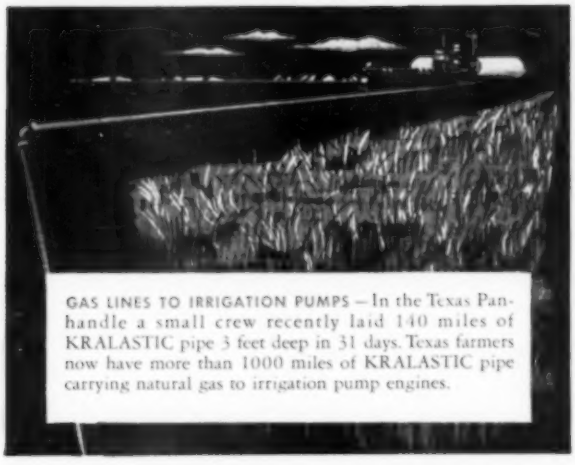
KRALASTIC Corrosion-Proof Pipe Makes Good in Many Fields!



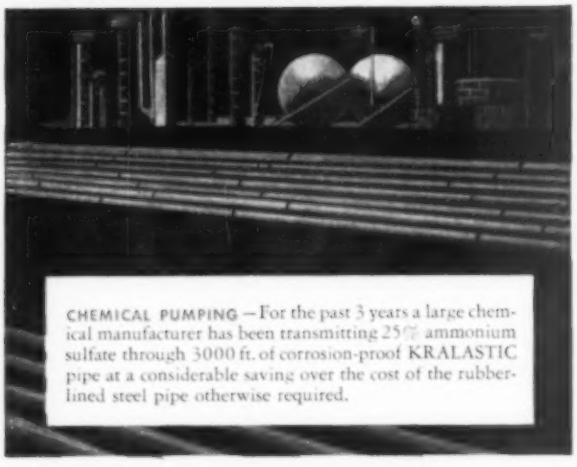
SALT WATER DISPOSAL—Operating under 20" to 28" of vacuum at 110° F. in a Texas oil field, a 4100 ft. stretch of 4" KRALASTIC pipe is still going strong after three years. A previous installation of pipe lasted only 6 weeks.



OIL FLOW LINES—Carrying very corrosive sour crude, a 1200 ft. section of 3" KRALASTIC pipe has performed satisfactorily for more than 4 years for a Texas oil company. Metal pipe previously used failed in only 4 months.



GAS LINES TO IRRIGATION PUMPS—In the Texas Panhandle a small crew recently laid 140 miles of KRALASTIC pipe 3 feet deep in 31 days. Texas farmers now have more than 1000 miles of KRALASTIC pipe carrying natural gas to irrigation pump engines.



CHEMICAL PUMPING—For the past 3 years a large chemical manufacturer has been transmitting 25% ammonium sulfate through 3000 ft. of corrosion-proof KRALASTIC pipe at a considerable saving over the cost of the rubber-lined steel pipe otherwise required.

KRALASTIC®, a unique combination of plastic and elastomeric materials, is different both in composition and physical properties from other materials used in the making of plastic pipe. It produces pipe—and many other plastic products—that are both hard and tough, low in weight, high in tensile strength and unaffected by most chemicals that corrode metals.

Pipe extruded of KRALASTIC has been approved by the National Sanitation Foundation for underground water transmission lines. Because of the inert nature of KRALASTIC, this pipe will not add taste or odor to drinking water and will not corrode and scale internally to cut down flow and pressure. For more information on KRALASTIC, write or phone us.

United States Rubber

Naugatuck Chemical Division

Naugatuck, Connecticut

BRANCHES: Akron • Boston • Gastonia, N.C. • Chicago • Los Angeles • Memphis • New York • Philadelphia • IN CANADA: Naugatuck Chemicals, Elmira, Ontario
Rubber Chemicals • Synthetic Rubber • Plastics • Agricultural Chemicals • Reclaimed Rubber • Latices • Cable Address: Rubexport, N. Y.

U. S. gross national product has been estimated by the President's Council of Economic Advisers at an adjusted annual rate of $427 billion in the first quarter. Gross national product is the nation's total of goods and services and is considered one of the indicators of economic activity in this country. The new estimate climbed $23.6 billion from year-ago figures and $3.2 billion from the previous quarter's rate. Report also showed that private domestic investment (business spending for plants and equipment) dropped $4 billion lower than the previous quarter total of $68.5 billion.

★ ★ ★

Public Information Committee of IPAA presented its first report at the midyear meeting April 30 in Biloxi. Alf Thompson, chairman, gave the report and recommended that the committee be expanded to include a member in each area, using the present committee as a steering committee and that the efforts of the program be coordinated with those of other oil and gas associations. This is the first public relations program set up by IPAA.

★ ★ ★

Three pounds of irradiated cobalt has been delivered to the newly-constructed Cities Service Research and Development Company laboratory at Cranbury, New Jersey. The metal, having a potency of 2½ times the world's supply of radium, is the largest to be sent from the Atomic Energy Commission's Brookhaven plant. Cities Service scientists will use the cobalt as a tool in the company's research program of study of refinery processes and in product development.

★ ★ ★

Robert B. Anderson, former director of W. T. Waggoner Estate in Texas and recently Deputy Secretary of Defense, is reported to be tapped again for government service. He is in line for job as Secretary of Defense or Secretary of the Treasury. At one time Anderson was considered for post of Under Secretary of State by Secretary Dulles.

★ ★ ★

OCAW Union authorized a pattern settlement between employees and oil companies on the basis of a 6 percent wage increase plus fringe benefits. Most companies had already agreed to the 6 percent raises and certain vacation and holiday improvements. The wage increase averages about 16 cents per hour and new vacation benefits offered by most companies grant 4 week vacations to 20 year employees. Union began its drive last December for a goal of 27 cent per hour increases.

★ ★ ★

110 octane gasoline will be needed to fire automobiles of 1960, predicts S. P. Blumberg, Humble Oil and Refining Company. He also forecasts manufacturing costs to supply the new fuel will rise 6 cents per gal and refinery investments will mount 40 percent to add the higher octane content. Blumberg bases the figures on a study on what could be accomplished by a 50,000 bbl a day integrated refinery.

★ ★ ★

Shale oil industry will boost population in northwestern part of Colorado from 50,000 to 500,000, says A. C. Rubel, president of Union Oil Company of California. Rubel also claims that commercial production of oil from shale is only five years away. Union has put over $15,000,000 into its present facilities that process about 400 tons daily. Union's president said a full-scale plant costing $200,000,000 might be built in 5 or 10 years, and would sell at competitive prices to that of crude — if granted the 27½ percent tax depletion Union is asking.

★ ★ ★

Seventeen leading oil companies are moving forward with plans to build a $840,000,000 pipeline to bypass the Suez Canal. Likely course of the 1,400,000 bbl crude line would be from the head of the Persian Gulf through Iraq and Turkey to the Turkish coast of the Mediterranean. Officials stressed in recent London meetings that the line would supplement, rather than replace, existing transportation facilities. First phase of the project would demand a 30 to 40-in. line to deliver 800,000 bbl a day to the Mediterranean.

★ ★ ★

Texas Independent Producers and Royalty Owners have gone one step further in objecting to Eisenhower administration amendments to Harris natural gas bill. Since the amendment proposals were first made (early May) through TIPRO's Galveston meeting (May 19-22), the group has prepared 11 amendments of its own to the bill to be submitted during testimony before the House Interstate and Foreign Commerce Committee.

Personal income hit a record high in April, the Department of Commerce reports. Annual rate of $339.3 billion was scored in April — $1.2 billion over the March rate and $18 billion above the yearly rate in April of last year. Nearly half of the increase in personal income was from higher and extended old-age benefits.

★ ★ ★

Continental Oil Company has arranged for bank credit of $75,000,000 to help foot bills being incurred in the U. S., Venezuela and Canada and to pay for expected acreage in Libya, other new concessions and for construction of new petrochemical plants. Of the total amount, $18,000,000 has already been borrowed at a 4 percent interest rate. Some 21 banks have agreed to provide the new working capital.

★ ★ ★

Jerome J. O'Brien of San Antonio has been named president of the Texas Independent Producers and Royalty Owners Association. O'Brien is vice president of Monterey Oil Company and is the first oil company official to become a TIPRO president; others have been individual operators. O'Brien succeeds A. E. Herrmann of Amarillo. New association secretary is Ridley Wheeler of Fort Worth, who replaces G. Scott Hammonds of Dallas. Vance Foster, Dallas, was re-elected treasurer. Harry C. Jones, Kilgore, was picked as state membership chairman replacing Johnny Mitchell, Houston. New officers were elected at the TIPRO annual convention meeting in Galveston, May 19-22.

★ ★ ★

"Sick and stagnant" oil indus- try, as inferred by former President Harry Truman brought quick rebuttals by Texas oilmen. Truman, in a recent speech in Dallas, said: "Industries which clamor for protection of tariff barriers are usually sick or stagnant industries to begin with — maybe like your downtrodden oil boys here in Texas. They are commonly advocates of low wage and high profit industries." One of the first to come to the aid of the domestic oil industry was Bruce Street, president of the West Central Texas Oil and Gas Association, who pointed out the high wage scale, low profits and commented on Truman's defense of the coal industry.

Good Wells Make Good News

June, 1957

RIVERFRAC*, an exciting new concept in hydraulic fracturing, is finding widespread use in many oil and gas producing areas. Large volumes of fresh water or unsaturated salt water are pumped into the producing zone at a high injection rate. Many authorities think salt removal is an important reason why Riverfrac is successful in some cases where other fracturing treatments have failed. Here are some results of Riverfrac.

- **Ward County, West Texas** (Old Well): This well, completed in the Yates at 3000 feet, had declined from 10 bopd to 1 bopd in about 18 months. Riverfrac, using 22,000 gallons of fresh water and 10,000 pounds of sand, removed 18,920 pounds of salt. Average injection rate was 34 bpm. *90 days after fracturing, well tested 115 bopd.*

- **Washington County, Illinois** (New Well): This well was completed in the Trenton Lime 4290-4400 feet open hole. Initial test was show of oil. Riverfrac was used. Fluid was 67,000 gallons fresh water with addition agents to control silicate swelling and emulsions. 55,000 pounds of sand was used. Fracturing was accomplished at average injection rates of 40 bpm. Although only 3600 pounds of salt was recovered, *well tested 95 bopd after treatment.*

- **Kay County, Oklahoma** (New Well): Completed in the Mississippian Chat 4154-4180, tested 6 bopd before treatment. Well was treated with Riverfrac, using 20,000 gallons of water with 20,000 pounds of sand at 37 bpm. *70 days following treatment, production tested 65 bopd with 40 bwpd.*

- **San Juan County, New Mexico** (New Well): Completed in Point Lookout Sandstone. Depth, 4805-5034 with four sets of perforations totaling 117 feet. Riverfrac was used. 256,196 gallons fresh water and 180,000 pounds sand were injected in four stages at 59-78 bpm. 160 rubber-coated nylon ball-sealers were used in one stage. Initial production: 30,000 cfpd. After treatment, well tested 7,400,000 cfpd. through ¾-inch choke at 506 psi. *Production was increased 247 times!*

Call Dowell. An experienced engineer will be glad to show you what's being done with Riverfrac in your area and discuss the possibilities of using this service in your wells. Or write Dowell Incorporated, Tulsa 1, Oklahoma.

Services for the oil industry

DOWELL

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*Service Mark of Dowell Incorporated

Youngstown's "big 5"

HELP MAKE ANY OIL OR GAS LINE INSTALLATION EASIER, QUICKER, LOWER IN COST

Here are the "Big 5" reasons why Youngstown Electric Weld Line Pipe is your best buy:

1. It bends readily
2. Wall thickness is uniform
3. Line up characteristics are excellent
4. Weldability is outstanding
5. Long lengths save you time and trouble

Why does the welder like to work with Youngstown Electric Weld Line Pipe? The answer is apparent! Youngstown Electric Weld Line Pipe is designed for easy welding. The same physical and chemical characteristics that make for perfection in welding at the mill also contribute to efficient, dependable welding in the field. Freedom from delays in welding, speed up installation of the pipe line—reduces contractors' costs.

Youngstown ELECTRIC WELD LINE PIPE

QUALITY YOUNGSTOWN SERVICE

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Meetings

June 2-6—**Air Pollution Control Association,** Golden Jubilee meeting, St. Louis, Missouri.

June 2-7—**SAE,** summer meeting, Chalfonte-Haddon Hall, Atlantic City, New Jersey.

June 3-5—**Petroleum Electric Power Association,** annual conference, Herring Hotel, Amarillo, Texas.

June 3-14—**Quantitative Electric Log and Radioactivity Log Interpretation and In Dipmeter Computation,** short course, Denver, Colorado.

June 4-6—**Appalachian Underground Corrosion Short Course,** Morgantown, West Virginia.

June 6—**Pennsylvania Grade Crude Oil Association,** 34th annual meeting, Penn-Sheraton Hotel, Pittsburgh, Pennsylvania.

June 9-12—**AIChE,** national meeting, Olympic Hotel, Seattle, Washington.

June 9-13—**ASME,** semi-annual meeting, Sheraton-Palace, San Francisco, California.

June 9-14—**API Division of Production,** midyear committee conference, Muehlbach Hotel, Kansas City, Missouri.

June 10-12—**Interstate Oil Compact Commission,** midyear meeting, Canyon Hotel, Yellowstone National Park, Wyoming.

June 12-14—**Operations Research Conference,** sponsored by Illinois Institute of Technology, Illinois Institute of Technology Campus, Chicago, Illinois.

June19-20—**Western Petroleum Refiners Association,** regional technical industrial relations meeting, Broadview Hotel, Wichita, Kansas.

June 19-21—**Association for Computing Machinery,** 12th annual meeting, Campus of the University of Houston, Houston, Texas.

June 23-27—**Canadian Gas Association** meeting, Jasper Park Lodge, Jasper, Alberta, Canada.

June 24-28—**American Institute of Electrical Engineers,** 1957 summer general, Sheraton-Mt. Royal Hotel, Montreal, Quebec, Canada.

June 26-29—**American Association of Cost Engineers,** first annual meeting, University of New Hampshire, Durham, New Hampshire.

July 8-19—**Industrial Statistics for the Process Industries,** short course, sponsored by the Extension Division of the University of Oklahoma and the Chemical Division of the American Society for Quality Control, University of Oklahoma, Norman, Oklahoma.

Aug. 26-28—**Appalachian Gas Measurement Short Course,** 17th annual, West Virginia University, Morgantown, West Virginia.

Aug. 28-30—**International Symposium on Gas Chromatography,** Analysis Instrumentation Committee of the Instrument Society of America, Kellogg Center for Continuing Education, East Lansing, Michigan.

Aug. 30-31—**Association of Desk & Derrick Clubs of North America,** annual meeting, Hilton Hotel, Chicago, Illinois.

Sept. 3-5—**Pacific Coast Gas Association Convention,** San Francisco, California.

Sept. 8-13—**American Chemical Society,** 132nd national meeting, New York City.

Sept. 9-13—**12th Annual Instrument Automation Conference and Exhibit,** sponsored by Instrument Society of America, Cleveland Auditorium, Cleveland, Ohio.

How to Keep
a Flood from
CHOKING TO DEATH

Identified as major causes of formation plugging are two microscopic miscreants—certain algae and several bacteria, particularly the sulfate-reducing bacteria. Counting on conventional treatment to remove these troublemakers is something like trying to trap mosquitoes with a picket fence ...most of them go right through and multiply mightily in the pores of the formation.

Diatomite filtration practically ends that threat by removing all algae and nearly all bacteria. That's the principal reason why many progressive operators today are filtering flood water with diatomite filter-aids such as Dicalite. Other advantageous features of diatomite filtration are the smaller space requirements, the lower capital investment and, most important, the complete salvability of a diatomite system.

An excellent example is this completely unitized diatomite filter system on a flood in West Texas. Three "Auto-Jet" filters, made by U.S. Filter Company, provide 1,500 ft² of filter area. 30,000 bbl/day of flood water go through this system; Dicalite Speedplus is being used as the filteraid. All units, including the precoat and slurry feeder tanks on the left, are skid-mounted for easy hauling.

For further information on Dicalite filtration of oilfield waters, write:

Dependable GLC GREAT LAKES Dicalite® DIATOMACEOUS MATERIALS

DICALITE DEPARTMENT, Great Lakes Carbon Corporation, 612 South Flower St., Los Angeles 17, Calif.

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MORE EFFICIENT OIL RECOVERY

from your flooding operations:

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INSIST upon these standards for your flooding medium

1. Chemical stability
2. Oil content zero
3. Iron content 0.2 parts per million
4. Turbidity 1 part per million

Most operators agree that these standards for the flooding medium (water, produced brine, or both) are necessary to minimize clogging of the input formation. INFILCO *complete* treating plants, which include the highly efficient ACCELATOR® Stabilizer, provide water within the specified limits. Closed systems, or other types of partial treatment, seldom meet these exacting requirements.

Existing INFILCO installations are treating over 500,000 barrels per day with three-way economy: lower first cost, lowest maintenance and low, low chemical costs. INFILCO engineers have over 30 years experience in designing *complete* flooding water treatment plants. Be sure you are getting maximum oil recovery by consulting your nearby INFILCO engineer. If you prefer, write for complete information.

THE **ONE** COMPANY offering equipment for **ALL** types of water and waste treatment

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Field offices throughout the United States and in foreign countries

5618A

Sept. 11-13—**National Petroleum Association,** 55th national meeting, Traymore Hotel, Atlantic City, New Jersey.

Sept. 15-18—**AIChE,** Lord Baltimore Hotel, Baltimore, Maryland.

Sept. 23-24—**Steel Founders' Society of America,** 55th fall meeting, The Homestead, Hot Springs, Virginia.

Sept. 23-25—**American Society of Mechanical Engineers,** Petroleum Division, 12th annual Petroleum Mechanical Conference, Tulsa, Oklahoma.

Sept. 26-27—**Western Petroleum Refiners Association,** regional technical-industrial relations meeting, Henning Hotel, Casper, Wyoming.

Sept. 26-27—**Louisiana-Arkansas Division Mid-Continent Oil & Gas Association,** annual membership meeting, Roosevelt Hotel, New Orleans, Louisiana.

Sept. 27—**Natural Gasoline Association of America,** Oklahoma regional, Skirvin Hotel, Oklahoma City, Oklahoma.

Sept. 30-Oct. 2—**American Oil Chemists' Society,** 1957 fall meeting, Netherland Plaza Hotel, New Orleans, Louisiana.

Oct. 1-2—**Texas Mid-Continent Oil & Gas Association,** 38th annual meeting, Texas Hotel, Fort Worth, Texas.

Oct. 6-9—**The Society of Petroleum Engineers, AIME,** 32nd annual fall meeting, Adolphus, Baker & Statler-Hilton hotels, Dallas, Texas.

Oct. 7-9—**American Gas Association,** annual convention, Kiel Auditorium, St. Louis, Missouri.

Oct. 7-9—**National Electronics Conference,** co-sponsored by Illinois Institute of Technology and two other universities and two technical societies, Hotel Sherman, Chicago, Illinois.

Oct. 7-11—**American Institute of Electrical Engineers,** 1957 fall general meeting, Morrison Hotel, Chicago, Illinois.

Oct. 13-15—**American Association of Oilwell Drilling Contractors,** 17th annual meeting, Mayo Hotel, Tulsa, Oklahoma.

Oct. 17-18—**AIME,** Southern California Petroleum Section, fall meeting, Biltmore Hotel, Los Angeles, California.

Oct. 23-24—**Computer Applications Symposium,** sponsored by Armour Research Foundation, Hotel Sherman, Chicago, Illinois.

Oct. 25—**Natural Gasoline Association of America,** southern regional, Washington-Youree and Captain Shreve hotels, Shreveport, Louisiana.

Oct. 27-29—**Independent Petroleum Association of America,** annual meeting, Statler-Hilton Hotel, Dallas, Texas.

Oct. 31-Nov. 1—**AAPG Mid-Continent** regional meeting, Cimarron Ballroom, Tulsa, Oklahoma.

Nov. 11-13—**Steel Founders' Society of America,** 12th Technical and Operating Conference, Carter Hotel, Cleveland, Ohio.

Nov. 11-14—**API,** 37th annual meeting, Conrad Hilton Hotel and Palmer House, Chicago, Illinois.

Nov. 12-14—**National Association of Corrosion Engineers,** Northeast region, fall meeting, Penn-Sheraton Hotel, Pittsburgh, Pennsylvania.

Nov. 13-14—**Air Pollution Conference,** co-sponsored by Armour Research Foundation and Midwestern Air Pollution Prevention Association, Loop Hotel, Chicago, Illinois.

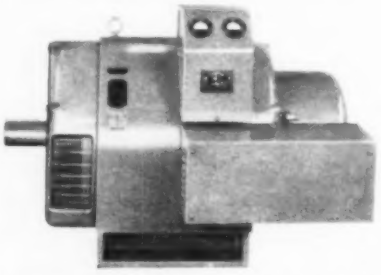
Nov. 22—**Natural Gasoline Association of America,** Panhandle Plains regional, Herring Hotel, Amarillo, Texas.

Dec. 8-11—**American Institute of Chemical Engineers,** annual meeting, Conrad Hilton Hotel, Chicago, Illinois.

Get the latest!

A COMPLETELY NEW "PACKAGED" GENERATOR

AMP-PAK



AMP-PAK Generator shown is rated at 187 kva, 1200 rpm, 240/480 volts. AMP-PAK is available in ratings of 75 thru 187 kva at 1800 rpm and 62½ thru 187 kva at 1200 rpm. Three phase, 80% PF, 60 cycles, 50C rise, and 120/208, 240 and 480 volts.

No exciter . . . No moving parts in the voltage regulator

AMP-PAK is a compact, revolving field a-c generator with built-in, static excitation system; static voltage regulator; and basic metering and controls conveniently grouped. AMP-PAK is a portable unit, factory assembled, internally connected, and tested

No rotating exciter to maintain. D-C excitation is provided by a heavy duty, long-life, static rectifier.

No tubes, relays, vibrators to service. Voltage is regulated by a static, E-M-developed sensing circuit and "magical" magnetic amplifiers.

Holds voltage "rock-steady" so your motors, lights, and electronic equipment will work better. The static regulator provides ±2% regulation.

Starts big motors. A special, built-in voltage booster transformer stands by to reinforce line voltage when heavy loads are suddenly applied.

Easy to install. Needs no switchboard. Just connect load to AMP-PAK thru a suitable line switch.

Simple to operate. Has no belts, no "tricky" commutator, no adjustments — anyone can operate AMP-PAK.

See your nearest E-M Sales Engineer and write the factory for publication PRD-236.

E-M

ELECTRIC MACHINERY MFG. COMPANY

Minneapolis 13, Minnesota

Largest manufacturer of "Packaged" Generators

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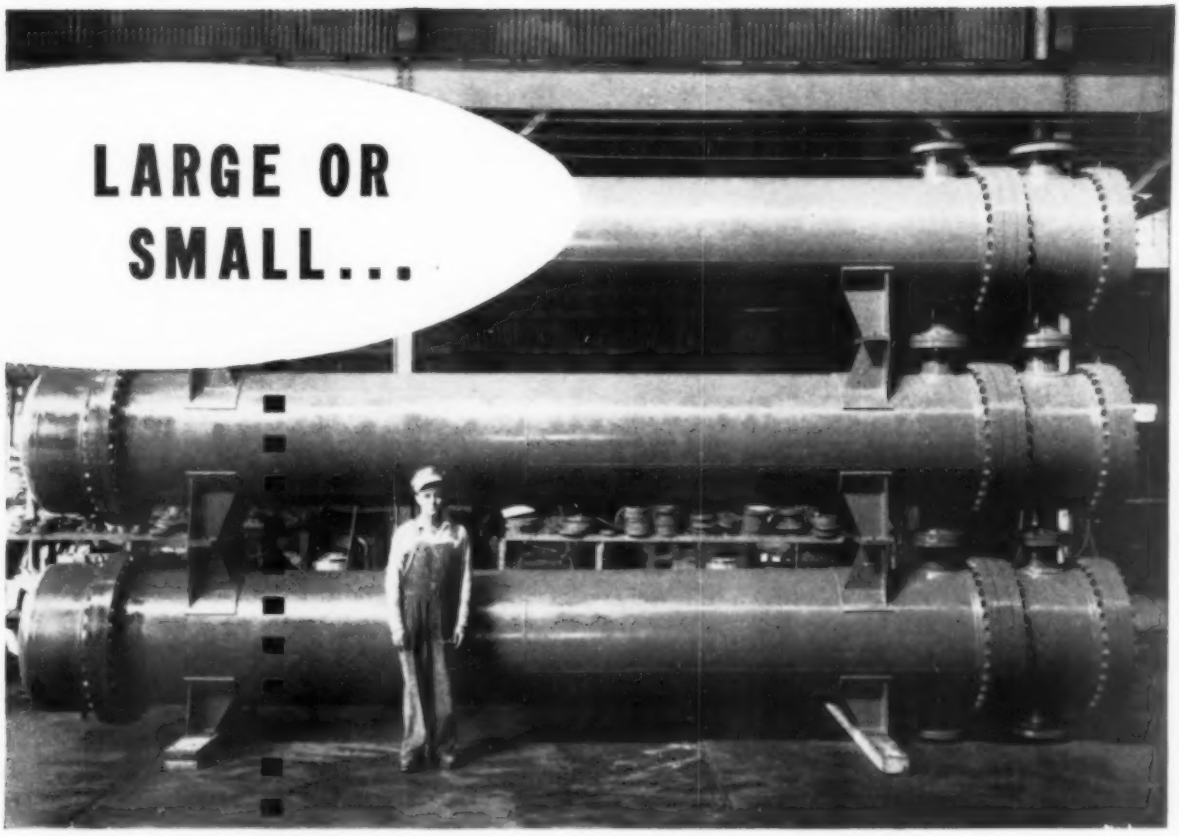

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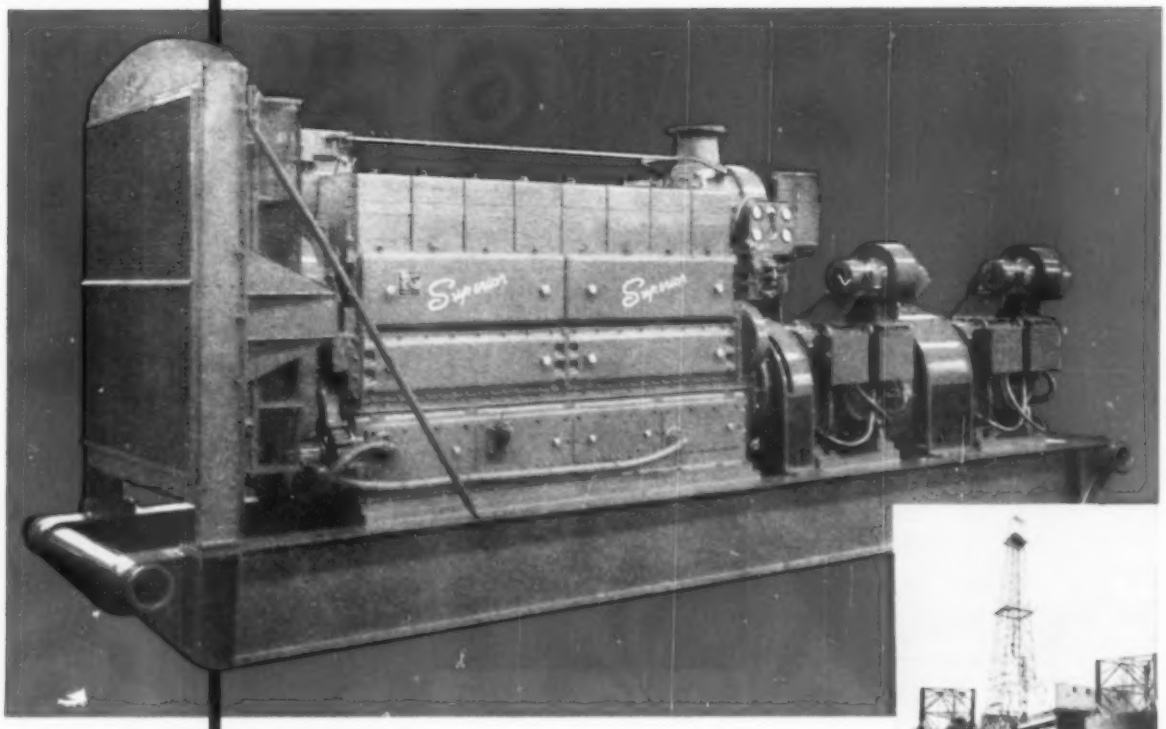
Yes, Virginia, gasoline does cost less than it did 30 years ago. (Before taxes, of course.) Most oilmen know this story; we know how the power in regular gasoline has climbed from 50 octane in the mid '20s to over 90 today. We know, too, what a fantastic value gasoline represents as a commodity. An industrial worker labored 23 minutes to buy a gallon in 1926; today he works just 6½ minutes for a better product. *We* know—but the public does not. What are *you* doing to tell them? **SHELL OIL COMPANY**

Dixilyn Drilling selects . . .

WHITE'S Superior Diesel-Electric



Lighter, extremely simple, more powerful drilling rig power plant!

Dixilyn Drilling Corporation of Odessa, Texas wisely chose White's Superior Diesel-Electric power for drilling operations to over 25,000 ft. deep from their LeTourneau mobile tripod platform, off the Louisiana Gulf Coast. The platform's 175 ft. spuds will permit drilling in approximately 105 ft. of water. The complete power package, including three 834 h.p. Superior engine-generator sets, will dependably provide a total of more than 2,500 h.p. From simplified controls, the driller can direct 2,000 h.p. to a National 1625 drawworks, or 2,000 h.p. to the mud pumps. Operational headquarters for the rig will be Morgan City, La.

More power for faster, deeper drilling—land or offshore, plus smoother overall performance, quicker response and extreme simplicity in arrangement and operation are the results of White's new important advancements and design refinements.

Components consist of 2 or more engine-generator sets, a minimum of 3 drive motors, and simple controls. White's well-known Superior oil field engine and rugged 300 to 550 kw generators in tandem make up an engine-generator set. Total weight of one set alone is almost 8 tons lighter than comparable units!

Power concentration in the heavy-duty drive motors also achieves simplicity, compactness and lighter weight. Largest drive motors are rated 1000 h.p. continuous and 1250 h.p. intermittently. This permits use of only one motor for the drawworks and one for each mud pump. Multiple motor linkages are unnecessary and controls are greatly simplified. All components are stocked, standard production items, ready for prompt delivery.

Get complete information from leading rig manufacturers, White's oil field representatives, or through White Diesel Engine Division.

White Diesel

WHITE DIESEL ENGINE DIVISION
THE WHITE MOTOR COMPANY

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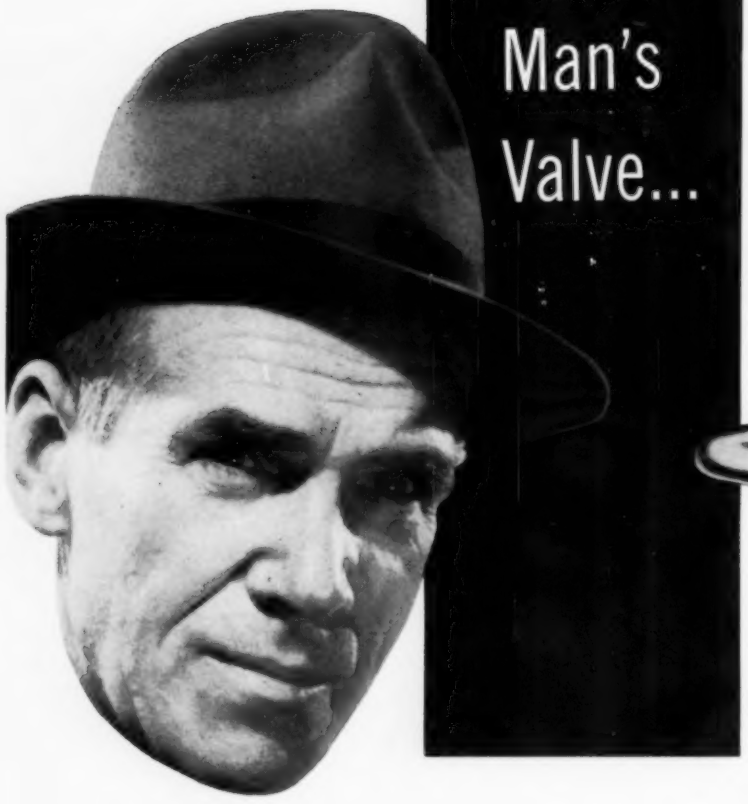

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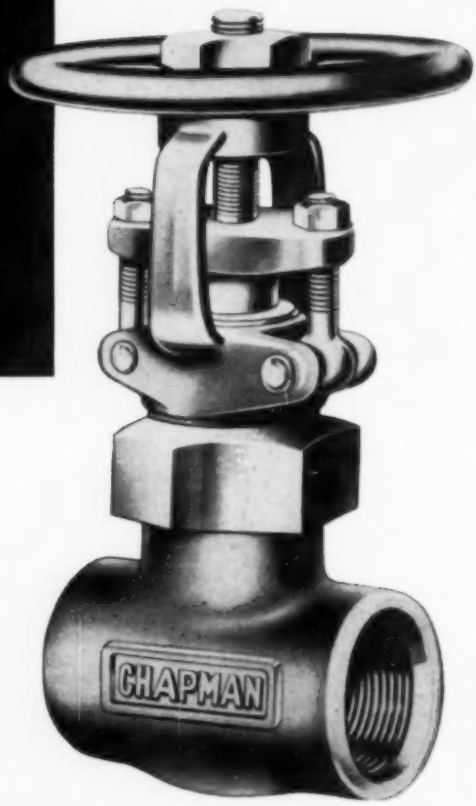
LIST 960
SMALL FORGED
STEEL GATE VALVE



There are good reasons why men-in-the-know specify Chapman List 960 for more jobs than other small forged steel gate valves. These reasons concern two important points . . . (1) long-range performance and (2) low-cost maintenance.

To begin with, Chapman List 960 valves have wedge faces that are super hard . . . tough enough for severe conditions. These wedge faces are hardened to 800 Brinell by Chapman's *exclusive Malcomizing process*. They can't seize or gall. And even the long-wearing, easily replaceable seat rings are made of hardened stainless steel.

There are no trouble-makers from top to bottom. No full-pressure repacking difficulties. No exposed threading.

For pressures from 380 psi at 1000°F. to 2000 psi at 100°F. (Anything higher, use Chapman List 990 valves.) Sizes range from ¼" to 2" . . . all in many alloy combinations. They come with rising stem with yoke or with inside screw. Bonnet joint ground metal to metal or gasketed, as you prefer.

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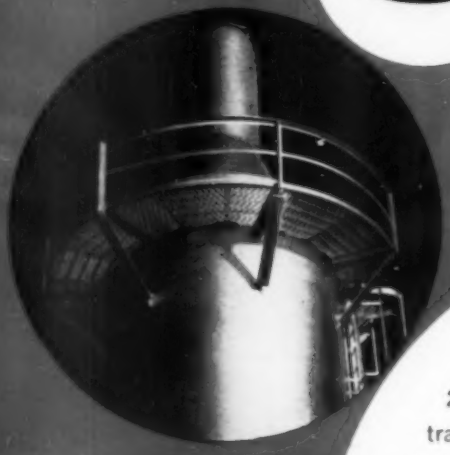
the comparative values of furnace design as applied to operating requirements.

It's quite simple

there are 9 basic factors which must be evaluated to obtain the full comparison of values



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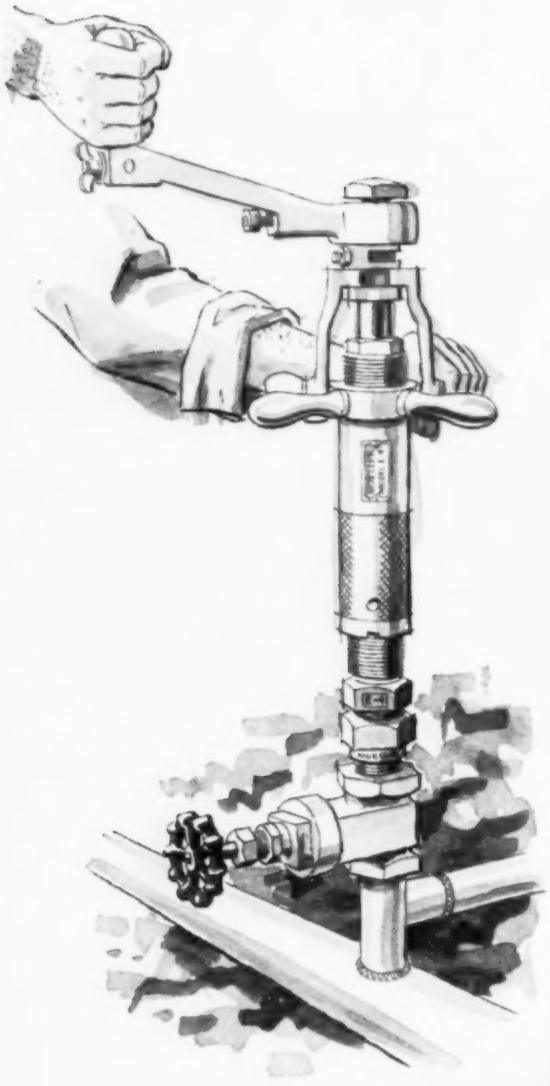

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- nipples ✓
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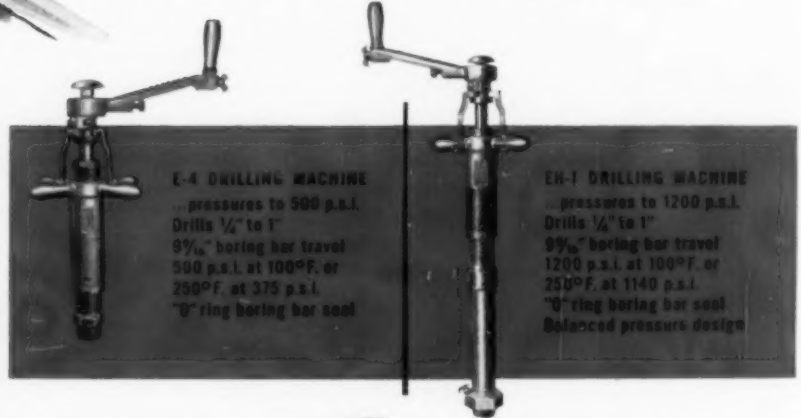
under pressure

These Mueller NO-BLO® Fittings – tees, valve tees, line stopper fittings, drilling nipples – can be installed in a line, tank or processing system without interrupting flow. The key to low or high pressure taps, without halting operations, is the Mueller® E-4 or EH-1 Drilling Machine. Taps are made under pressure by using a gate valve between the machine and the pipe. Integral valves or plugs in the fittings keep the fluid under control. The E-4 or EH-1 can also make stop-offs to isolate a section for repair or additions.


E-4 DRILLING MACHINE
...pressures to 500 p.s.i.
Drills ¼" to 1"
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250°F. at 375 p.s.i.
"O" ring boring bar seal
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...pressures to 1200 p.s.i.
Drills ¼" to 1"
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1200 p.s.i. at 100°F. or
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Balanced pressure design

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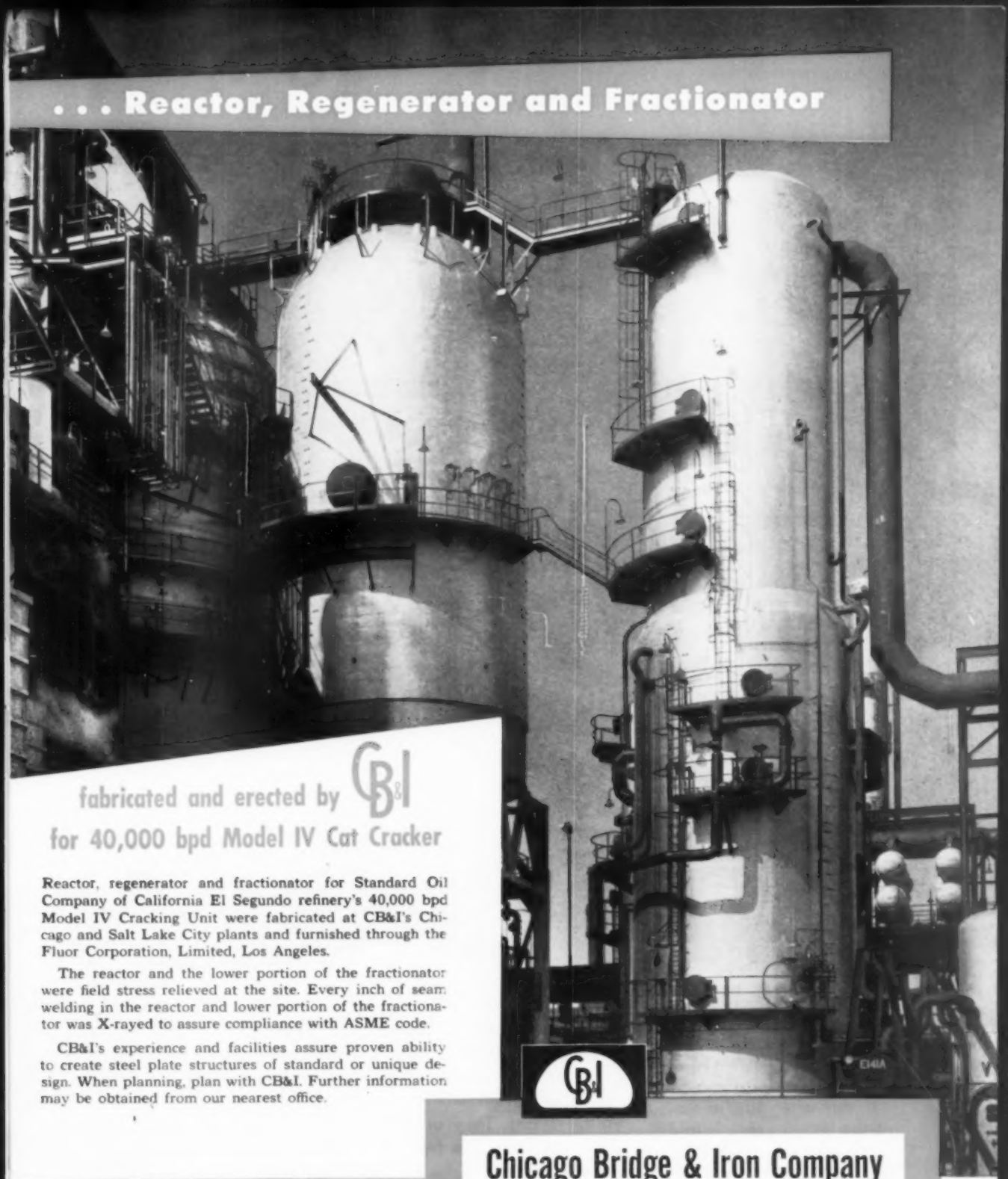

fabricated and erected by CB&I for 40,000 bpd Model IV Cat Cracker

Reactor, regenerator and fractionator for Standard Oil Company of California El Segundo refinery's 40,000 bpd Model IV Cracking Unit were fabricated at CB&I's Chicago and Salt Lake City plants and furnished through the Fluor Corporation, Limited, Los Angeles.

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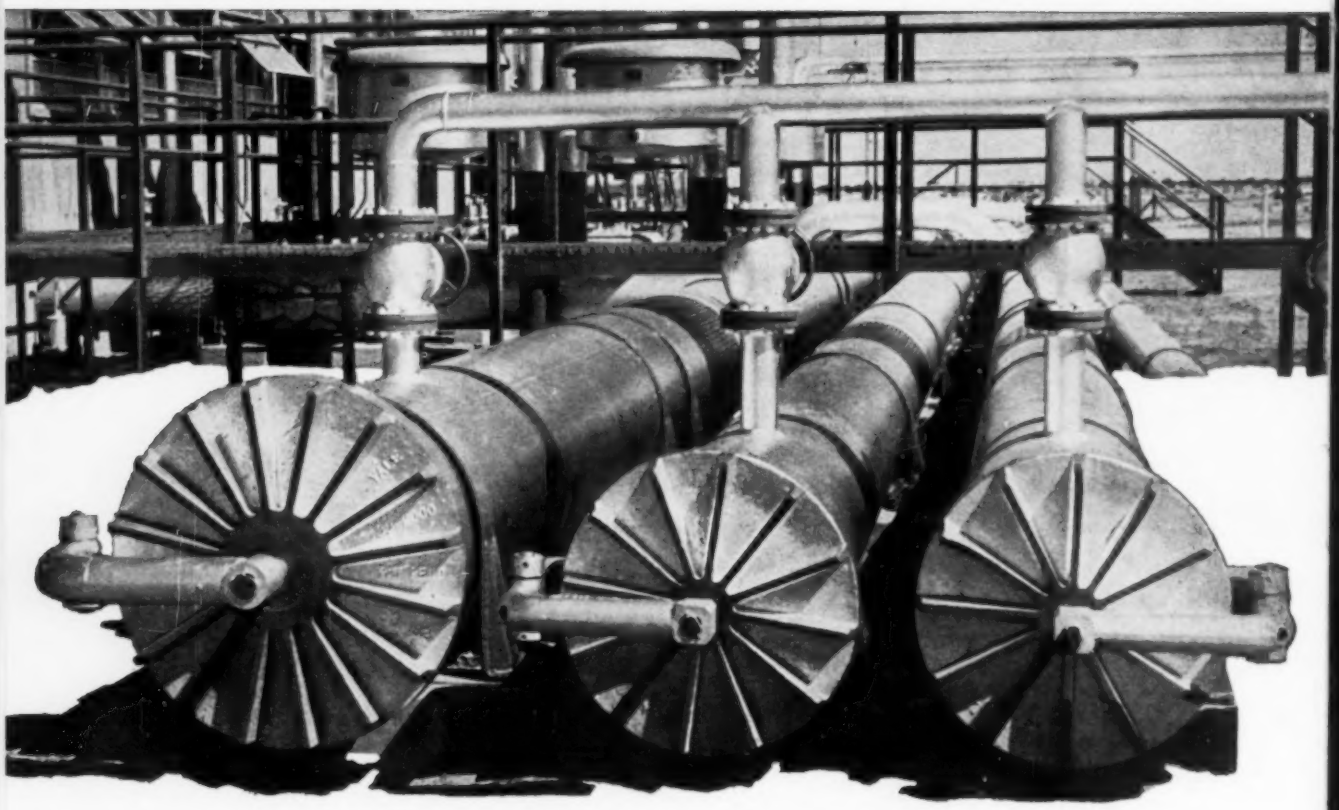

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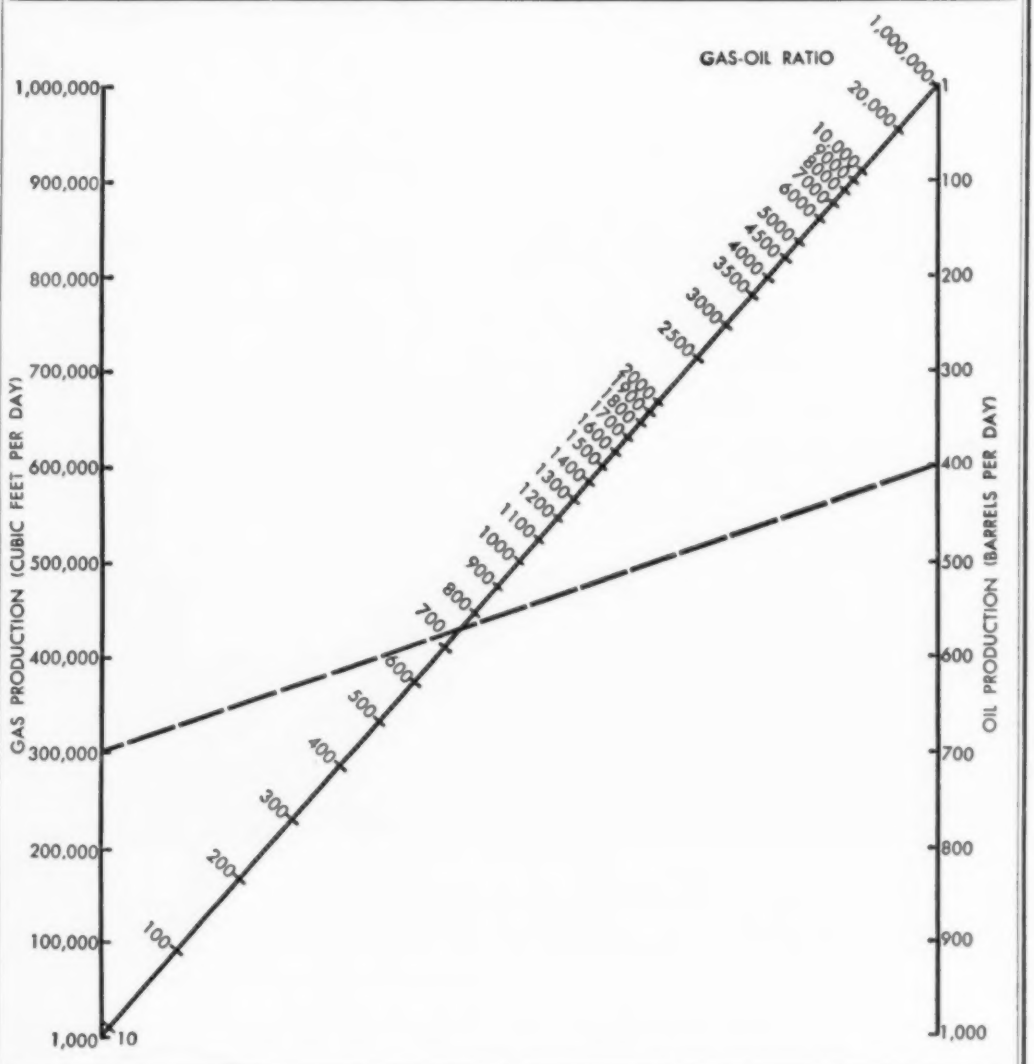
Gas-Oil Ratio Alignment Chart



Gas-oil ratios may be rapidly determined with this chart and a straight-edge when the volume of gas and quantity of oil production is known.

Example:

Given: 300,000 cu. ft. of gas per day
400 bbl. of oil per day

Solution: Lay a straight-edge from the 300,000 cu. ft. point on the gas production scale to the 400 bbl. point on the oil production scale (indicated by dashed line). The answer is found on the diagonal gas-oil ratio scale = 750 cu. ft. per bbl.

Note: Although the production scales are marked "per day," the production need not be converted to daily rates to obtain the correct answer. For example, suppose the production is 300,000 cu. ft. of gas and 400 bbl. of oil in 12 hours. A straight edge laid between these points show the gas-oil ratio = 750 cu. ft. per bbl. The same answer would be shown, if the production had been multiplied by 2 to obtain the "per day" rates of 600,000 cu. ft. of gas and 800 bbl of oil and these two points connected by a straight-edge.

It is important to be sure the gas and oil production figures are for the same period of time. The length of the period is immaterial.

If the production figures are not within the range of the chart, they may be divided by a common denominator. Thus, if the production was 3,000,000 cu. ft. of gas and 4,000 bbl. of oil in 10 hours, these figures might be divided by 10 to obtain 300,000 cu. ft. and 400 bbl. of oil. The gas-oil ratio could then be determined as in the example (dashed line) = 750 cu. ft. per bbl.

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Crude Oil Line Uncovered After 11 Years... The 10¾" SOMASTIC Coated pipe line shown at the left had been underground in irrigated sandy loam, generally corrosive, for over 11 years when housing developments required that it be uncovered and lowered. Inspection of the line revealed *no deterioration* and *no repairs were required.* In fact, the line was in such good condition that it was never raised above ground. Note in the picture how trenching operation permitted line to be moved to the right, out of its former position, and lowered to its new position.

...AND MORE PROOF!

Natural Gas Line Uncovered After 11 Years... The close-up of the 8⅝" SOMASTIC Coated pipe at the right is typical of the natural gas line uncovered after 11 years underground in alkali uncultivated soil under a dry lake bottom. Note the *lack of damage!* Any physical or chemical changes that had occurred were so slight that *normal handling* methods were employed and the pipe re-used.

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Natural Gas Line, SOMASTIC Coated, Was in Excellent Condition after 11 Years under Dry Lake Bottom.

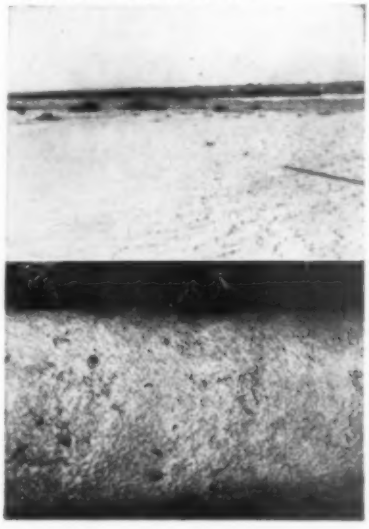

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CHART FOR ESTIMATIO[illegible] OF NATURAL GAS RESERVES

This chart is based on data contained in the article, "Effect of Reservoir Depth on Gas Reserves," by K. Marschall Fagin as published in the October, 1945, issue of *The Petroleum Engineer*, pages 256 to 260, clusive.

*This chart is applicable to an acre-ft. of gas sand that has 9801 cu. ft. of effective porosity and produces 0.6 gravity gas.

**Standard cu. ft. at 14.65 lb. per sq. in., abs., and 60°F., using a terminal well head pressure of 125 lb. per sq. in., ga.

***The depth scale is applicable only to initial gas field pressures that are "normal," that is equivalent to a hydrostatic head of 435 lbs. per 1000 ft. of depth.

EXAMPLE:

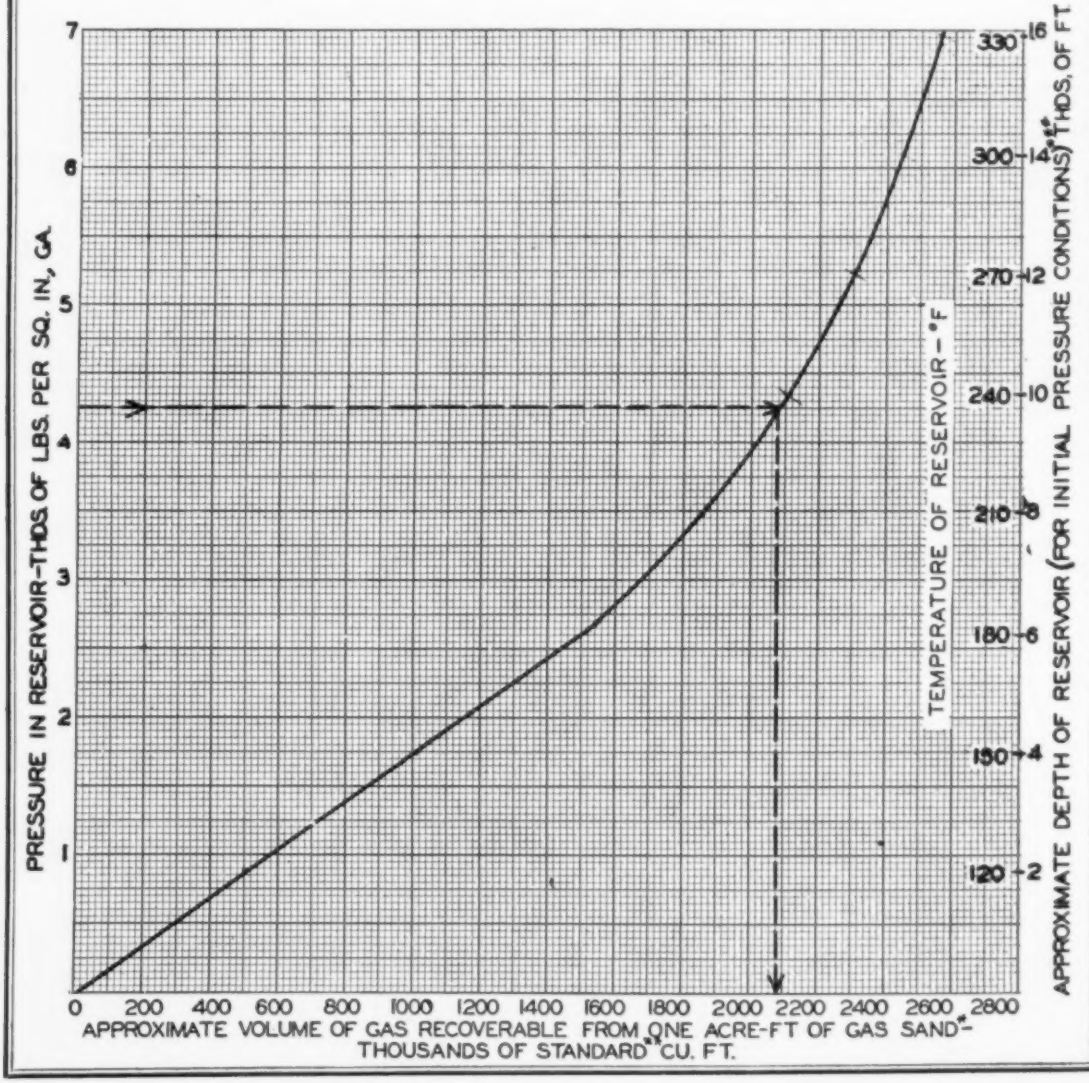
Given: A new gas reservoir with an initial pressure of 4250 lbs. per sq. in. ga., having sand with 9,801 cu. ft. of effective porosity per acre-ft., reservoir temperature of 237°F., and producing 0.6 gravity natural gas.

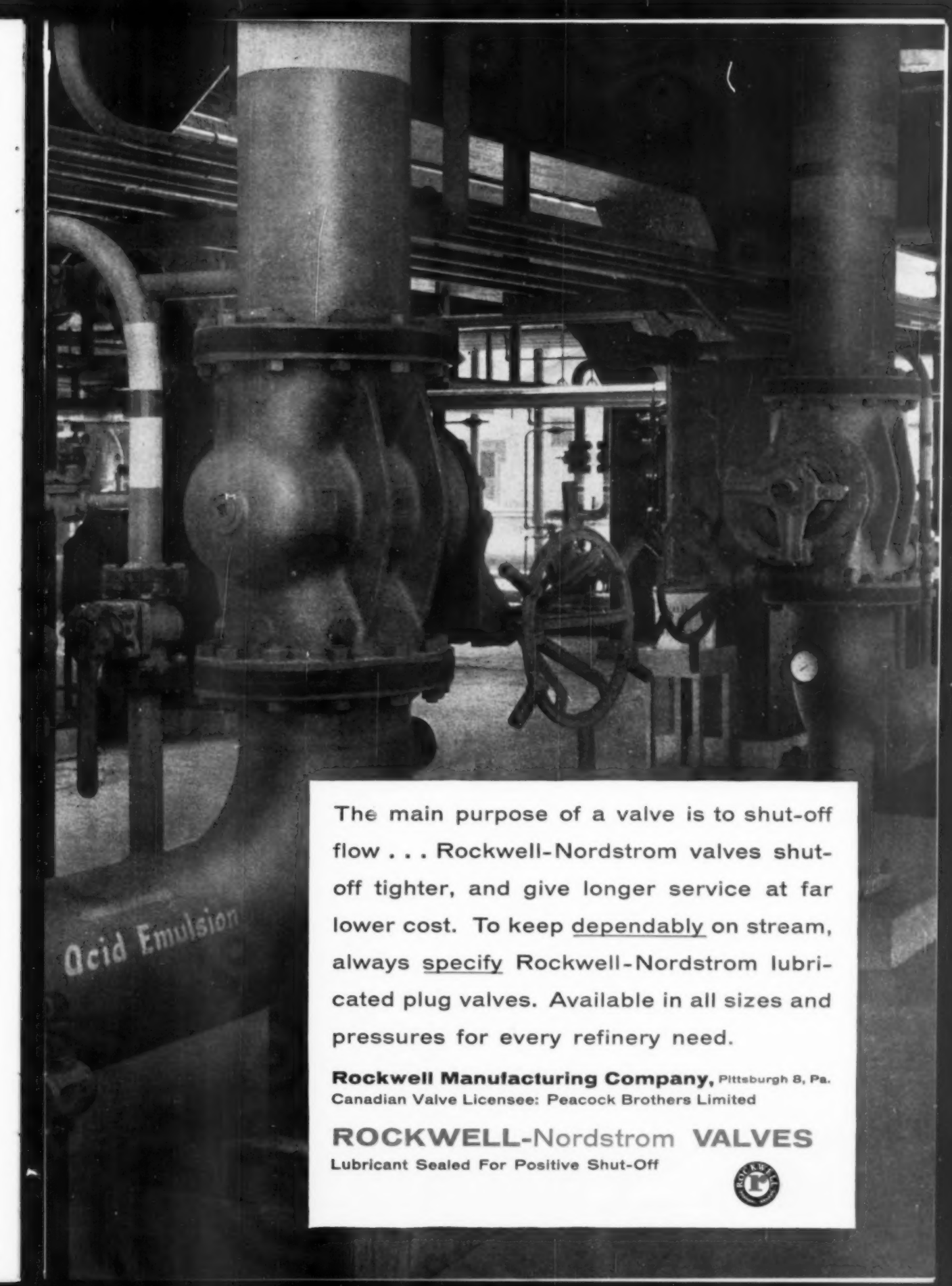
Required: An estimate of the ultimate recovery of gas per acre-ft.

Solution: Enter the chart from the 4250 lb. point on the pressure scale (as indicated) and proceed to the intersection with the curve. The answer, 2080 cu. ft. is found on the "recovery" scale directly below the intersection.

Note: The effective porosity of the gas sand = 43,560 cu. ft. × per cent porosity × (100 — per cent connate water).

If the effective porosity of the gas sand in question is more or less than 9,801 cu. ft., the recoverable volume of gas will be proportionately more or less.





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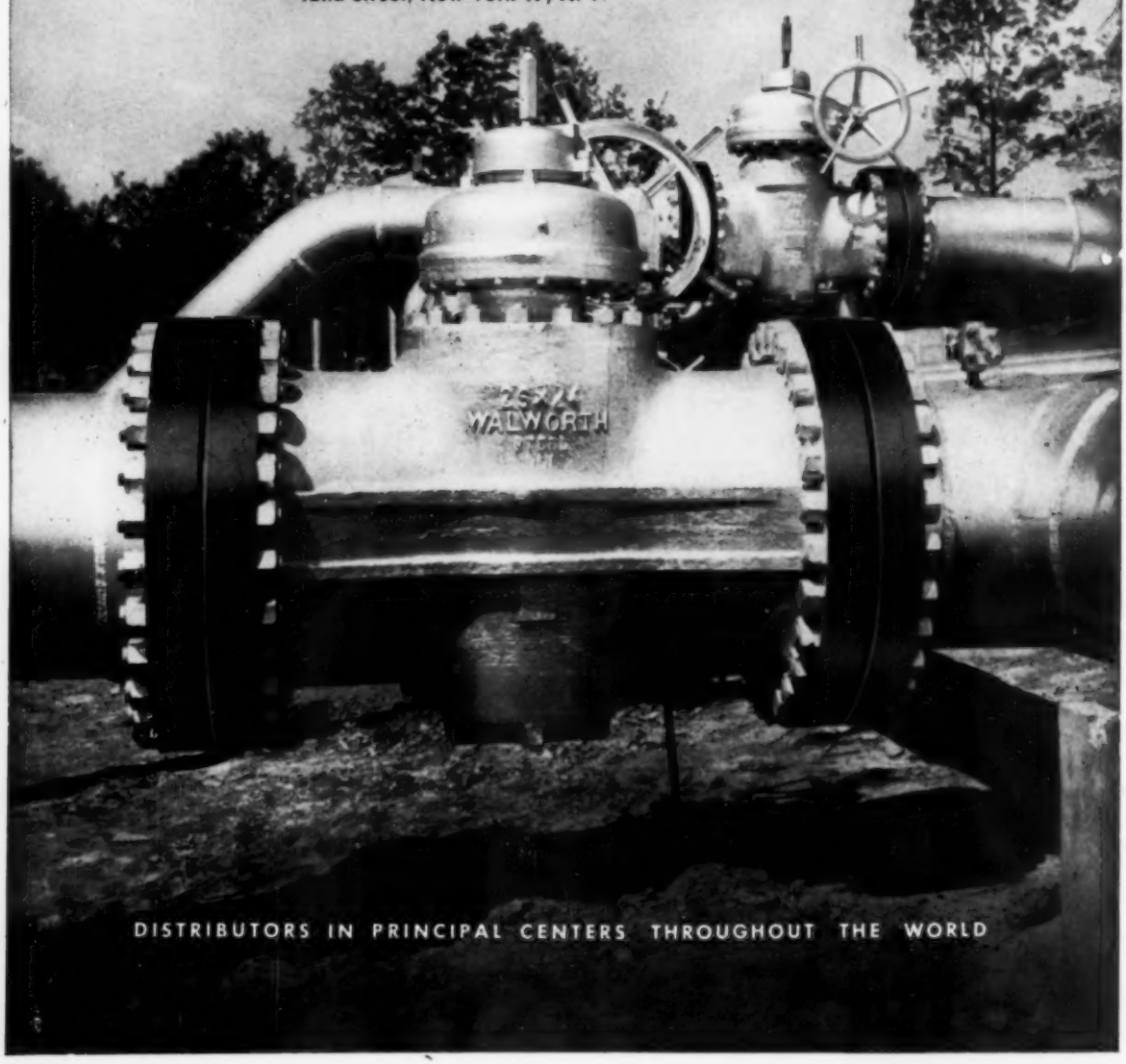

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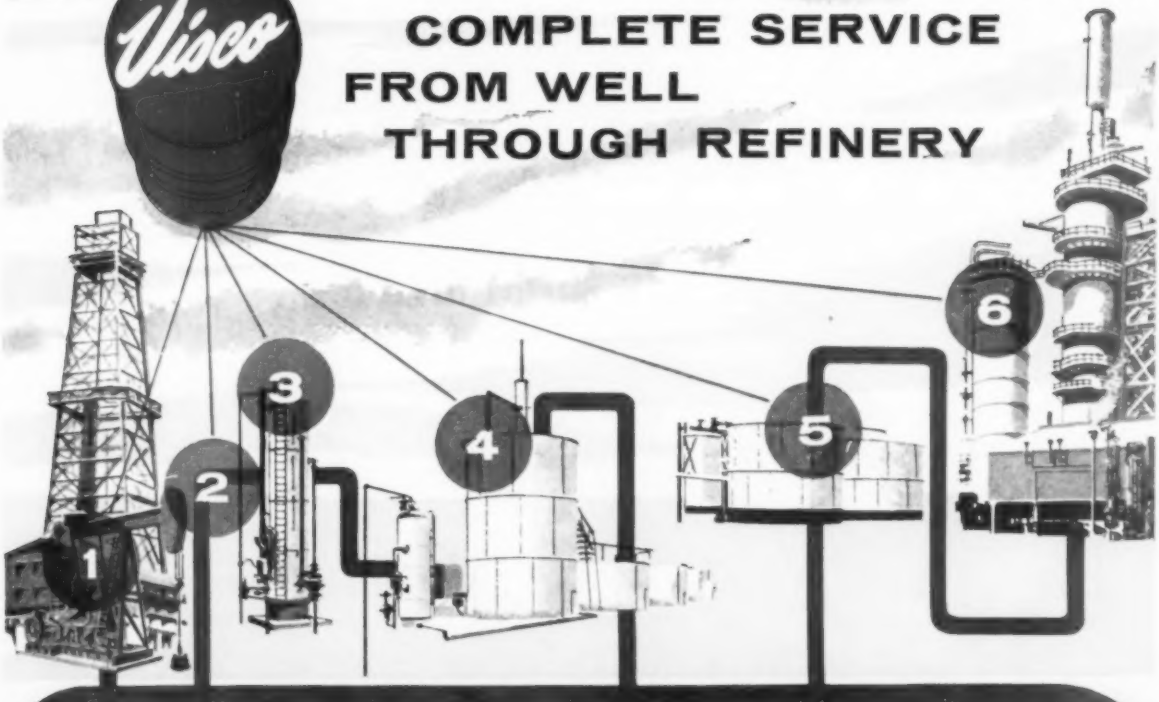

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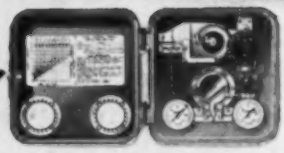
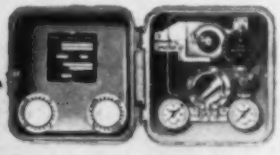
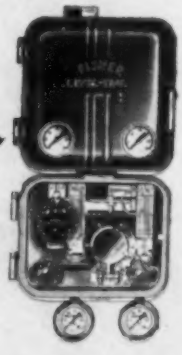


TYPE 2500—proportional pilot for general liquid level control applications.



TYPE 2500T — Level-Trol pilot used as pneumatic level transmitter.

TYPE 2500C—pilot with level indicator. Indicator available on all style Level-Trol pilots.



TYPE 2500 — 2516 dual Level-Trol pilot consisting of Type 2500 for remote level-indication or recording and Type 2516 controller with proportional and reset response.

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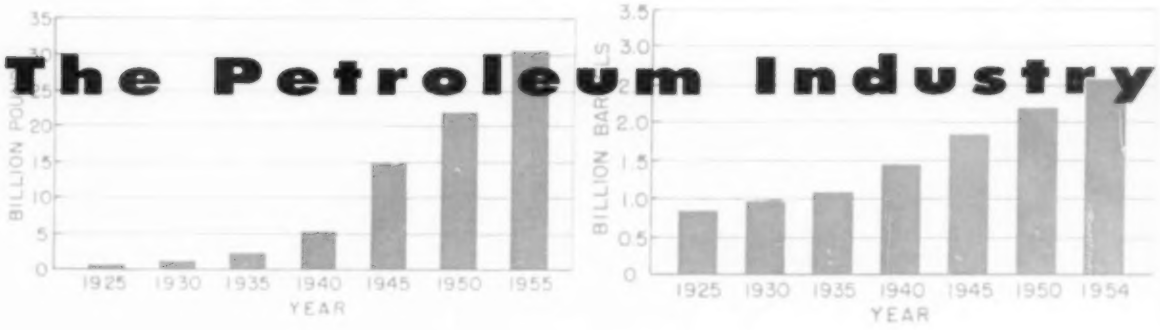

Source of Chemical Raw Materials

In 1940 only 5% of organic chemicals in the United States were derived from petroleum . . . in 1955 the figure was more than 25% . . . by 1962 it will be 50% . . .

W. E. Kuhn and J. W. Hutcheson

THERE has been a chemical industry in this country for over 300 years. William Haynes in his history of the American Chemical Industry states that the first cargo of American manufactured wares shipped from Jamestown, Virginia, to London, England, in 1608, was surprisingly chemical in its make-up. There were "trials of Pitch, Tarr, Glass, Frankincense (probably pine rosin), Sope-ashes; with what Wainscott and clapboard that could be provided." Thus, it is pointed out that Captain John Smith became, if not our first chemical manufacturer, at least our first chemical entrepreneur.[1] That segment of the industry which deals with synthetic organic chemicals, such as pharmaceuticals, dye stuffs, solvents, and so on, was begun commercially in the United States during the last half of the Nineteenth Century, but it dates effectively from World War I. Since that time the manufacture of organic chemicals in this country has grown steadily and rapidly. Fig. 1 depicts this growth from the 500 million pounds produced in 1925 to the present production which is in excess of 30 billion pounds per year. The industry is a multi-billion dollar one.

The petroleum industry is much younger than the heavy chemical industry. It did have its beginning about the same time as the first synthesis of organic chemicals in the United States, however. The Drake oil well of 1859 was preceded by some five years by the first petroleum refinery. Samuel Martin Kier in 1854 set up and operated a one-barrel still in Pittsburgh, Pennsylvania. The first refined product was called "carbon oil" and was introduced on the market as an illuminant. A by-product of the distillation was sold to a carding mill in Cooperstown, Pennsylvania, where it was used to clean wool.[2] Since that time, the petroleum industry has greatly expanded. Production in the United States during 1954 amounted to over 2.5 billion barrels of liquid hydrocarbons and nearly 9.5 trillion cubic feet of natural gas.[3] The petroleum industry, too, is a multi-billion dollar business. Fig. 2 shows the growth in domestic production of liquid hydrocarbons; i.e. crude oil and natural gasoline, since 1925.

These two great industries must have come very close together on products and processes during their early growth. With our technology of today it is difficult to understand how they remained apart as long as they did. The two industries began to overlap during World War I. During this period shortages developed for many chemicals needed for military and civilian uses. Among the more critical of materials

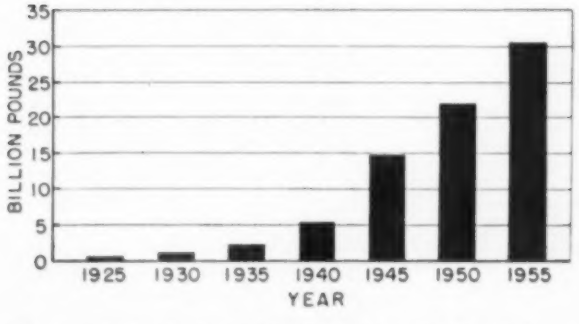

FIG. 1. U.S. Production of Synthetic Organic Chemicals.
Source: U.S. Tariff Commission

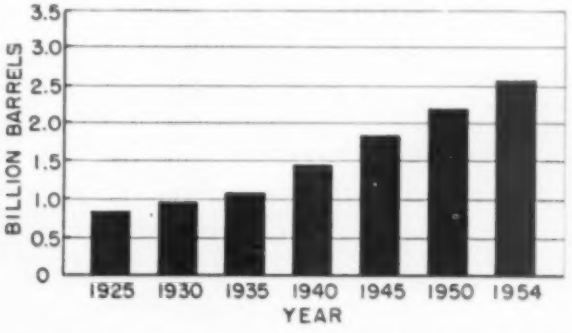

FIG. 2. U.S. Production of Crude Liquid Petroleum Hydrocarbons.
Source: U.S. Bureau of Mines, API and Oil Record

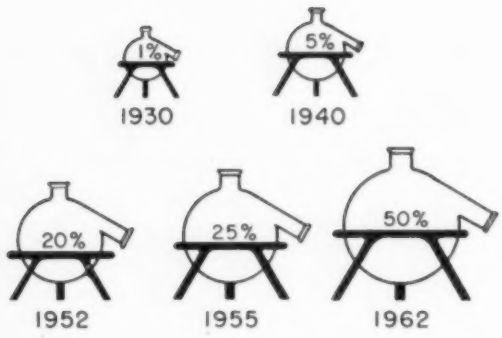

FIG. 3. Petroleum as a Source of All Chemicals. (Poundage Basis)

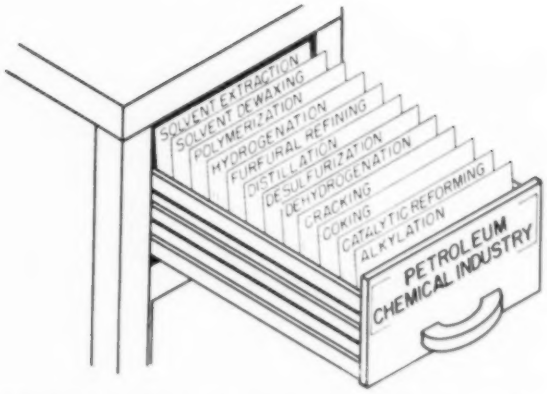

FIG. 5. Relationship of Petroleum and Chemical Processing.

was toluene which was required for explosive manufacture. Several petroleum companies carried out severe cracking operations on selected petroleum fractions and were able to recover the small percentage of aromatics formed, including toluene. The Texas Company was one of the first of the oil companies which engaged in this type operation. After World War I when toluene demands lessened and prices declined, the petroleum companies found they could not compete economically with the materials available from the coking industry. Consequently, interest became dormant for a time.

At a meeting of the New Jersey Chemical Society on December 13, 1920, Carleton Ellis described the process by which he achieved the first commercial production of isopropanol from propylene. In 1917 he had formed Melco Chemical Company to operate the process. During the war, the Bureau of Aircraft Production took over the pilot-plant in order to make acetone from the isopropanol produced.[4]

These were among the first significant blendings of the petroleum and chemical industries — one activity for aromatics and one for aliphatics. It was the production of aliphatic chemicals from petroleum that grew most rapidly. The production of isopropanol from propylene began to flourish and ethylene derivatives in the form of ethylene glycol and its derivatives made appearances on the American market in the early 1920's.

In spite of these revolutionary developments, the use of petroleum products as raw materials for chemical manufacture grew slowly. In Fig. 3 it will be noted that by 1930 about one per cent of the chemicals produced in this country was derived from petroleum. In 1940 only about five per cent were so obtained. But the courting days were over. World War II brought about a union of the chemical and the petroleum industries. The resulting chemical expansions have exceeded the expectation of all except perhaps the most optimistic forecasters. By 1952 petroleum supplied the raw materials for over 20 per cent of the U. S. chemical production. Last year (1955) it surpassed 25 per cent. In a paper published in 1951 we estimated that by 1962 one-half of the chemicals produced in this country will come from petroleum sources.[5] Present evidence indicates that this prediction will come true, and it is possible that the 50 per cent point may be reached before that time.

You will note from the title that we have chosen to emphasize the petroleum *industry*, rather than just petroleum, as a source of chemical raw materials. It is the petroleum industry which has prospected, discovered, drilled, and produced the petroleum from which basic hydrocarbons having the necessary characteristics for chemical synthesis are obtained. Several factors which have contributed to the increasing use of these fundamental hydrocarbons are shown in Fig. 4. The petroleum industry has been able to make the products available in adequate supply without the seasonal fluctuations often noted in raw materials of vegetable or animal origin. The cost of petroleum derivatives has been kept low enough to encourage their use in chemical manufacture with the added benefit of proven price stability.

Basic petroleum hydrocarbons can be supplied as relatively pure compounds or as mixtures which can be economically separated. The simple chemical structure of these hydrocarbons provides many benefits in organic syntheses. The purity and simplicity of petroleum hydrocarbons is, in general, in contrast to the raw materials available from other sources.

There are many more factors which might be mentioned, but certainly the ease of handling and transporting these basic petroleum hydrocarbons is one which cannot be overlooked. Few chemical raw materials are transported

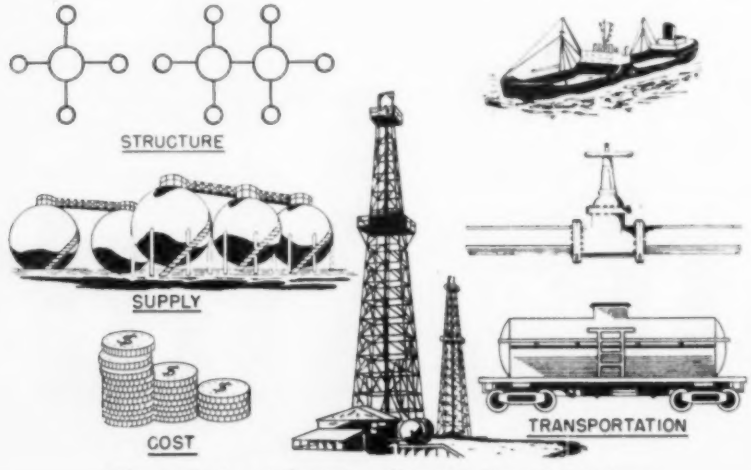

FIG. 4. Factors Influencing Chemical Use of Petroleum Hydrocarbons.

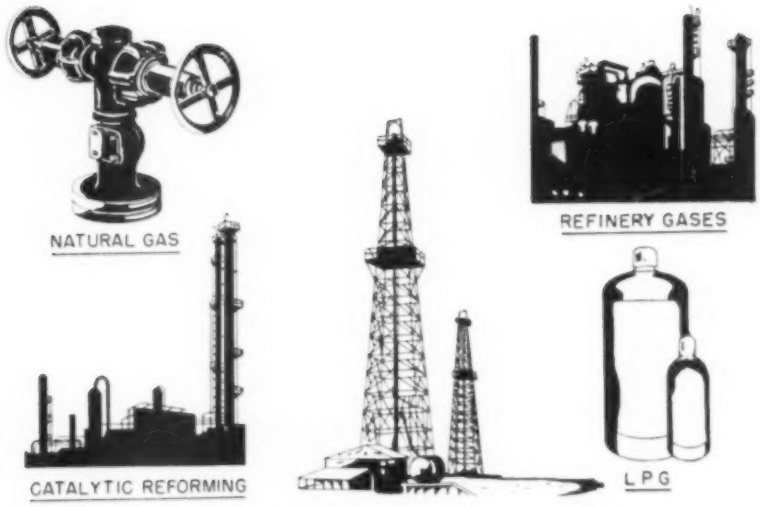

FIG. 6. Sources of Raw Materials for Petroleum Chemicals.

so far, by as many means of transportation, or stored in so many ways as those from petroleum.

There is still another contribution of the petroleum industry to the supply of chemical raw materials which is of paramount importance. It is the processes and technical "know-how" developed by the petroleum industry. These processes have made available additional supplies of the basic hydrocarbons and have provided a new source of more complex raw materials. In addition, the processes and techniques of the petroleum industry have allowed the chemical industry to expand into new fields and to more efficiently use the raw materials available. The petroleum industry is noted for its leadership in the development of continuous operations. Numerous batch-type processes once used by the chemical industry have been converted to continuous operations by applications of techniques developed by the petroleum industry.

Let us examine a few of the more important petroleum processes, illustrated in Fig. 5, to see how they have contributed to the petroleum chemicals industry.

Cracking

The thermal cracking of crude oil, and crude oil fractions necessary to make petroleum products, results in the formation of a small percentage of gaseous products. These gases contain methane, ethane, ethylene, propylene, and butylenes as well as minor amounts of other materials. The first large-scale petroleum chemical operations used these refinery off-gases. Today, these hydrocarbons are also available from catalytic cracking. As refinery capacity has increased in this country, so has the availability of the gaseous hydrocarbons. The olefins present are of particular interest for chemical manufacture. The techniques of cracking as developed by the petroleum industry are now employed in the preparation of ethylene from ethane, and ethylene and propylene from propane.

Alkylation

The reaction of an olefin with isobutane was commercially developed by the petroleum industry as a means of increasing gasoline quality. The technique also has been applied as a means of placing side chains on an aromatic nucleus. This process is now employed as a means of providing the chemical industry with needed raw materials. The large-scale availability of ethylbenzene and cumene can be traced to pioneering work of the petroleum industry's interest in these materials. In today's low-cost alkyl aryl sulfonates for making synthetic detergents, the alkylation of an aromatic with an olefin has almost entirely replaced the older process which involved the alkylation of the aromatic with an alkyl halide.

The Authors

Dr. Wayne E. Kuhn is general manager of the Research and Technical Department of The Texas Company. After receiving a BA degree in science from Reed College in Portland, Oregon, in 1925, Kuhn was awarded a PhD in chemistry from Cornell in 1929. He entered the service of The Texas Company in 1929, as a chemist at Bayonne, New Jersey.

In 1950 Dr. Kuhn was awarded the Honor Scroll of the New York Chapter of the American Institute of Chemists.

John W. Hutcheson is the project leader of Market and Utilization Studies in the Chemicals Research Department of The Texas Company's main research center in Beacon, New York. A native of Missouri, he received his BA from Central College, Fayette, Missouri, in 1939 and an MS in chemistry in 1941 from Oklahoma A & M.

He joined The Texas Company in 1941. Hutcheson is a member of the American Chemical Society, the Chemical Market Research Association and the Commercial Chemical Development Association.

Dehydrogenation

The dehydrogenation of n-butylenes to butadiene, pioneered by petroleum companies, materially hastened the establishment of the synthetic rubber industry in this country. Five oil companies organized in 1942, engineered, and later operated Neches Butane Products Company, the largest butadiene plant in the world. This operation is now carried out jointly by the petroleum and chemical industries through Texas-U.S. Chemical Company and Goodrich-Gulf Chemical Company.

Dehydrogenation is also employed to obtain styrene, the other component of GR-S synthetic rubber, and to prepare certain olefins such as isobutylene and the pentylenes.

Polymerization

Polymerization was developed in the petroleum industry to convert gaseous olefins into liquid products having value in motor fuels. The same products or ones of higher or lower molecular weight made by the same process are finding increasing uses in chemical applications. Polymers of propylene or butylene, as well as mixed polymers, are articles of chemical trade in numerous industries including those making synthetic detergents, petroleum additives, and alcohols by the Oxo process.

Catalytic Reforming

One of the more recent petroleum processes to gain importance in supplying raw materials to the chemical industry is catalytic reforming. By this process naphthenes and paraffins of specified boiling ranges are converted into aromatics including benzene, toluene, and xylenes. For petroleum, these materials are used to improve the quality of gasolines. The lack of sufficient aromatics from coal and coke sources has resulted in making the petroleum industry an important supplier of benzene and the predominant supplier of toluene and xylenes.

Time does not permit a complete review of the chemical raw materials prepared by processes pioneered or developed by the petroleum industry. Comments similar to these already made could be extended to operations such as:

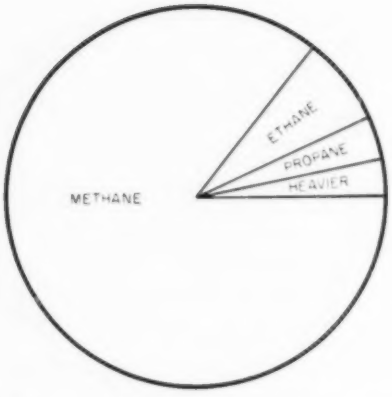

FIG. 7. Typical Composition of "Wet" Natural Gas.

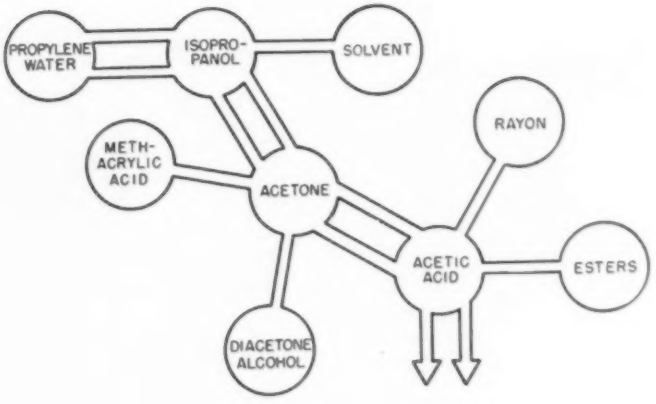

FIG. 8. Petroleum Chemical Chain Reaction.

Distillation	Desulfurization
Solvent Extraction	Coking
Solvent Dewaxing	Hydrogenation
Furfural Refining	Treating
	Decarbonization

With the swing to petroleum as a source of raw materials for chemicals a whole new industry has developed yet its boundaries are difficult to establish. Many chemical companies have altered and expanded their activities, petroleum companies have broadened their base of operation, and new companies, sometimes joint ventures of chemical and petroleum companies, have been formed—all because chemicals can be made from petroleum.

Let us more critically, but briefly, examine the major types of chemical raw materials from the petroleum industry to see where they originate in petroleum operations, and how they are modified or used in chemical operations. As shown in Fig. 6, the major chemical raw materials are refinery gases, natural gas, liquefied petroleum gas and catalytic reformer streams.

Refinery Gases

The initial expansion of the petroleum chemicals industry was made possible by the availability of low cost refinery gases. The cracking and reforming of the hydrocarbons present in crude oil results in the formation of a small percentage of gaseous materials. These vary with the charge stock and the type and condition of the refining operation. Some typical compositions of by-product gas obtained in a number of refining operations are given in Table 1, below.

Of the materials available, the C_3 and C_4 hydrocarbons are most easily recovered. The propylene and butylenes find use for direct chemical conversion. As much as 70 per cent of all propylene requirements may be traced to refinery gases. The remainder is obtained by cracking propane from natural or refinery gas which is carried out to obtain ethylene as a primary product. About 75 per cent of the requirements of butylenes are recovered from refinery gases. The balance is derived by the dehydrogenation of butanes.[6]

The ethylene contained in refinery gases is more difficult to recover in sufficiently high purity for most chemical processes. In 1954, Henry Groppe of Monsanto Chemical Company estimated that only 10 per cent of the ethylene consumed in 1952 was recovered directly from refinery gases and 40 per cent was produced by pyrolysis of ethane extracted from refinery and natural gas. Almost all of the remainder was derived by cracking propane, with minor quantities obtained from heavier hydrocarbons.[7]

Further increases will be made in the nation's refining capacity and this will result in a corresponding increase in the volume of refinery gases. Changes in the technology in refining operations, changes in crude sources, and changes in the types of fuels and lubricants to be produced will all have an influence on the type and amounts of the constituents in the gas stream. The combination of factors will place a ceiling on the ultimate supply, which will be considerably below future demands for some components. It is expected that the major demands for propylene and butylenes will continue to be met by refinery gases. Demands for ethylene will probably result in improved techniques for its recovery from refinery gases but the bulk of the future ethylene demands will come from cracking ethane and propane from refinery and natural gas.

The future will continue to see the majority of chemical plants using propylene or butylene being located near refineries. All future plants for ethylene chemicals will not necessarily be built near refineries.

TABLE 1. Typical compositions of refinery gases.
(Per Cent by Volume)

	Mixed-phase cracking	Reforming	Vapor-phase cracking	Polyforming	Catalytic cracking
Hydrogen	3	7	7	7	7
Methane	35	40	30	50	18
Ethylene	3	4	23	8	5
Ethane	20	18	12	25	9
Propylene	7	6	14	3	16
Propane	15	10	4	6	14
Isobutane	2	3	1	—	16
n-Butane	8	7	2	1	5
Butenes	7	5	6	—	10
Butadienes	—	—	1	—	—

Natural Gas

The greatest source of gaseous hydrocarbons is found in natural gas. The composition of natural gas varies slightly depending on its source, but Fig. 7 shows a composition which may be taken as typical of most "wet" natural gas[8]; it is, methane, 80 to 90 per cent; ethane, 5 to 10 per cent; propane, 3 to 5 per cent. The remainder includes butane, 1 to 2 per cent; and pentanes and heavier hydrocarbons, 1 to 2 per cent. It is necessary that natural gas be

processed to remove the heavier hydrocarbons before it can be placed in a pipe line. In the process of removing the heavier hydrocarbons of natural gasoline from natural gas, the capture of certain amounts of lighter hydrocarbons such as ethane and propane is unavoidable. The ethane-rich stream is suitable for cracking to ethylene. The propane-rich and butane-rich streams from processing natural gas may be liquefied and the material transported and marketed as liquefied petroleum gases for chemical manufacture and fuel uses.

The methane in natural gas is used extensively in the production of methanol, ammonia, acetylene, and carbon black. About 60 per cent of the American ammonia production is based on methane.

Natural gas will play an increasingly important role as a source of chemical raw materials. Greater emphasis will be placed on the recovery of ethane, propane, and butane for chemical utilization. Greater emphasis on the separation and use of C_2 and higher hydrocarbons at points along gas transmission lines can be anticipated in order to place chemical operations closer to consuming markets. Limiting factors to the use of natural gas are the rising costs which increase the price of the gas at the wellhead, and increasing transmission costs.

Changes have already taken place to shift or to consider a shift in the raw materials for carbon black and ammonia manufacture. Carbon black is now being made in increasing quantities from oil and petroleum fractions other than natural gas. The Texaco Synthesis Gas Generation Process[9] is being employed to provide hydrogen for ammonia manufacture from either natural gas, heavy fuel oil, or coal. This process allows greater freedom in locating plants in or nearer consuming market areas. With strategic location of plants an important economic factor, this petroleum industry development provides an expanding base for another phase of the petroleum chemical industry.

Liquefied Petroleum Gas

Liquefied petroleum gas, LPG, is composed primarily of propane and butanes which have been recovered from natural gas or refinery operations. Approximately 28 per cent of all the LPG produced in this country finds its way into chemical operations. The butanes are suitable for dehydrogenation to butylenes and the n-butylenes are further dehydrogenated to butadiene. The propane is used as a cracking stock for the preparation of ethylene. Direct oxidation of propane and butane results ultimately in the production of aldehydes, alcohols and acids.

LPG can be expected to continue to fill an important role in supplying propane and butane for chemical conversion. However, the demand for LPG for use as domestic and industrial fuel is growing and the price which will be forthcoming in these outlets will tend to limit somewhat the future growth of LPG for chemical conversion.

Catalytic Reformer Streams

The demands for higher octane motor fuels has brought about certain changes in refinery processes. One such process leading to higher octane fuels is catalytic reforming. In this operation the naphthenic hydrocarbons and some of the paraffinic hydrocarbons are transformed or "reformed" into aromatics. The result is a higher grade gasoline for the petroleum industry, or a source of important aromatic chemicals for the chemical industry.

The value of aromatics from petroleum is one of economic balance. When aromatic stocks from coal are inadequate and demands are high, then aromatics from petroleum are economically attractive for the petroleum refiner. Petroleum aromatics cannot compete with by-product aromatics from the coal industry when demands are low.

Petroleum will continue to supply the major portion of the toluene and xylene requirements of the chemical industry. Demand for benzene over and above that which can be economically produced by the coal industry will likewise be met by the petroleum industry. The petroleum industry will also supply more of its captive demand for benzene for chemical conversion.

Other Petroleum Fractions

Certain petroleum fractions are suitable for the production of carbon black and can be converted into a source of hydrogen for ammonia manufacture, mention of which has already been made. Other petroleum streams yield products which also are of chemical importance. These materials include sulfonates, naphthenates, cresylic acids, hydrogen sulfide, carbon dioxide and hydrogen. Supplies of such products from petroleum will continue to increase as refining capacity is increased. Further considerable research will be extended to improve the quality and quantity of these materials.

Summary

A continued growth is assured for the petroleum chemicals industry. The type and variety of products which can be made seem unlimited. As an example, Fig. 8 illustrates what presently is happening to most of the propylene currently being chemically consumed. The reactions are almost chain-like or they might be compared with a nuclear reaction. Once they are started they continue on and on, directed, of course, by the surrounding conditions. What are now our ultimate products may not be end products in five years but building blocks to chemicals or products yet unknown.

In the years to come, increased demands will be placed upon the petroleum industry by the chemical industry to furnish raw materials for chemical manufacture. The chemical and petroleum industries will become more closely associated in the future than they have in the past. Such association will have no great effect on the overall supply of petroleum products. It is estimated that the current consumption of petroleum hydrocarbons by the chemical industry is only about one per cent of the annual gas and liquid hydrocarbon output. Consequently, the petroleum industry utilizes in four days as much of these materials as the chemical industry utilizes in a year. Therefore, chemicals represent a relatively small activity for the petroleum industry but a very lucrative one since the return on chemicals per barrel of crude is roughly five times as great as the return on conversion to gasoline and other petroleum products. Even with the continued swing of chemical raw material supplies to petroleum origins, it is not expected that the supply of petroleum hydrocarbons will be greatly affected. By 1965, chemical raw material demands should not greatly exceed two per cent of the annual petroleum output.

The chemical industry recognizes and benefits from many of the new and unique technical processes developed by the petroleum industry. New developments in processing can be expected from the petroleum industry, and they will undoubtedly influence the petroleum chemicals industry of the future.

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★ ★ ★

Have you ever thought of practicing human relations to keep your personnel work in shape? Here are some exercises to take that will firm up flabby areas

How to Be HUMAN ON THE JOB

Wallace G. Strathern

MORE and more people in a supervisory capacity are becoming acutely aware of the need to be persuasive and human when they carry on the work of inducting workers, giving orders, handling grievances, and the many other phases of supervision.

Human relations is simply a well-worn phrase for dealing effectively with workers. Much has been written on this subject — so much, in fact, that I would hesitate to offer these suggestions but for the fact that I feel there is need for information on the "how" of putting human relations to work.

Learn to Like People

An associate of mine defines "horse sense" as "That which keeps horses from betting on people." This is sort of looking "horse sense" in the mouth so to speak, and indicates a rather skeptical attitude toward people in general.

It seems to me that it is "horse sense" to "learn to like people."

An interesting question to ask ourselves right here is, "Do I like people? — not just some people — but do I really like all the people with whom I work?

It is clear that a supervisor must be flexible enough to adjust himself to other people for the purpose of encouraging their best effort on the job. To do this we must learn to like people. This is not an impractical blue sky idea, but a down-to-earth, dollar-and-cents suggestion that always pays off.

It starts with a conscious effort to try to like all of our workers and associates with whom we come in contact. It means going out of our way to find things that we can like about each person. It sometimes involves a conscious effort to impersonalize (remove from the person) that which is wrong, and to look for that which is good.

If there are things about some of our workers and associates that it is impossible for us to like, then we have to give extra thought and attention to those qualities which we can like and admire. One trait, or poor quality, does not make the whole man. We must not make the mistake of disliking the whole man merely because of something about him that displeases us.

How to Like People

Sometimes we have to practice liking our fellow workers. A good exercise for us is to pick out someone in our department or on the job whom we never did especially like, and make the effort to see if we can't like him. Let's start by asking ourselves why it is we do not like him. It may be possible that we feel he does not like us. If so, let's try to do something that will prove to him we are his friend.

For example, let's try to do something to make him feel important, and do it very sincerely. Let's ask the worker a simple favor. (People like to do favors.) Let's ask him for his advice on something of current interest. (Folks love to give advice.) Let's point out that we are interested in some of the things that he is. Or, let's cater to some small want or need that he may have. (You can get a terrific kick out of giving people things — little things that cost very little.)

Our attitude toward this man and all of our associates should include being approachable at all times, giving him a helping hand whenever we can, showing and convincing him that we have confidence in him, and helping him save his face when he makes a mistake.

This planned, broad-minded attitude toward our workers always develops enthusiasm for people. This enthusiasm results in a stronger desire to see how much we can improve a worker, how much better work we can get from him by intelligent handling — by real human relations.

Be Generous With Honest Praise

One road to successful supervision and enjoyment of your job lies through appreciation — honest appreciation.

What do men work for? Of course they work for money, or more accurately, what money will buy — food, clothing, a home, and such things; but men want much more than money. They want honest appreciation for work well done. Deep down each one of us has an urge to be respected and appreciated.

Zenn Kaufman tells the story of a poor tramp who was walking along a dusty road and a farmer came along and gave him a ride in his wagon. They went down the road a piece and met Farmer Perkins who said, "Hi, Si, whatcha got?"

The farmer said, "Oh, just a load of manure and a tramp."

They went down the road a piece farther and met Farmer Crockett who asked the same question and got identically the same answer. This time the poor tramp went up to the front of the

The Author

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Strathern coordinates the training for 10 companies within the group. He is an author and speaker on the subjects of selling and human relations.

wagon, tapped the farmer on the shoulder and said, "Please, mister, next time mention me first."

Which indicates that all men—every one of us — crave appreciation. And note the word. It isn't want, wish, desire, but "crave" appreciation. Because this is so, the ability to praise men honestly and effectively is an important tool for good human relations.

Appealing to a man's pride gives him a feeling of confidence and satisfaction.

Please note that we do not refer to flattery or buttering a man when he has not done a good job. Men resent silly and sentimental praise, but nearly always respond to honest and well-deserved appreciation of work well done.

One of the most common gripes from workers is, "I don't know whether I am doing a good job or not. My boss never tells me." A man who is doing a good job should be told so, and he won't get a big head if we do it properly.

The old-fashioned attitude of so many supervisors, "Everything is all right unless I tell you otherwise," is dead wrong and it always was.

We should remember that it is sometimes best to praise the work rather than the worker. When we praise the work rather than the workman, his fellow workers cannot question our judgment or knowledge of the man.

People endeavor to live up to praise and to justify it; whereas criticism and indifference will often kill a desire to put in extra effort.

Listen: People Like Good Listeners

A friend of mine has a little sign on his desk which reads, "Dear Lord, help me to keep my big mouth shut until I know what I'm talking about." What a grand rule for supervisors, and what a tough rule to follow.

Did you every stop to think that you never learn anything while you are talking. And yet the only way to solve problems with workers is to learn the facts, to get the low-down, to listen.

Most everyone agrees that we ought to be good listeners, and yet it is one of the hardest things we have to learn to do. There is a strong urge to interrupt a story or explanation as it is being told. We want to get in a word here and there, especially if what the person says is contrary to what we believe or understand. We can't wait to show that the other fellow is wrong!

We must learn to listen, to hear the whole story, and not to interrupt.

If we will listen to the worker's whole story, we can learn whether a reprimand is needed, whether the worker has all the facts, something about his attitude; and best of all, we impress the worker with our fairness.

How to Listen

It is easy to assume that once we decide to listen there is no particular trick to it, but actually there should be a quality to our listening that includes close attention, a friendly attitude and alertness.

We have all watched supervisors who were going through the motions of listening, but whose minds were obviously miles from where they should be. Not to pay attention to the speaker is just plain discourtesy. Now of course we don't mean to be discourteous. Perhaps there are a dozen reasons why it is hard to pay close attention, but it is costly because we may have offended the worker and we often lose information that we need.

In addition to being attentive and friendly we need to be alert. Now and then we must say something. It can, and perhaps should, be brief; but if we are alert, it will fit into the conversation. What we say will prove our attentiveness and friendliness. Such statements as, "That's interesting!" "What did you do then?" "I see your point," help the speaker and are an important part of listening. To do this we must be alert.

Giving Counsel

The practice of being a good listener is 99 percent of the technique of being a good counselor. When our workers are in trouble, they often feel the need to tell somebody about it; but they want to talk out their problems with someone whom they respect. A good supervisor — as we have said — should be approachable. His understanding manner will encourage men to confide in him.

Very often men in trouble say they want advice, but what they really want is a sympathetic friend. We know that the very act of telling one's troubles will often bring a solution without a word of advice from others. At any rate, once an employee has told his problem to someone in detail, it never seems so bad to him.

Since as supervisors we should like to be rated as both human and smart, it will pay to listen — people always like good listeners!

Talk in Terms of "You" Not "I"

Joe Cooke says, "Of all my wife's relatives I like myself the best." That's Joe's interesting way of reminding us that our chief interest is ourselves.

Now intelligent self-interest is right and needed; but since we cannot and would not want to live alone, self-interest surely includes the best and easiest way to persuade people to our way of thinking.

Since we are talking about being human, let's refer to that rule in the world's best seller, the Bible, which says in effect — Do unto others as you would have them do unto you.

If we accept this rule as useful and practical for everyday use (and it most certainly is), we will make a conscious and constant effort to talk in terms of "you" not "I."

How is it done?

Well, it requires some thinking and planning before we talk. When we give an order, make a request, or sell an idea, we try to put ourselves completely in the worker's place. We try to feel and understand his point of view. We ask ourselves, "If I were this man, the worker, how would I feel toward this (plan, suggestion, order, idea)?"

When we talk in terms of the listener's interest, we use ordinary conversation, but it is usually organized in a little different way than we are used to; but, how this kind of planning and organizing pays off!

It's a very human mistake when we see a worker doing something the wrong way, or see poor plans or ideas being used, to jump right in and criticize the worker for doing what we know to be wrong and costly.

For example, take the foreman in the plant who sees a worker using a grinding machine but not wearing his goggles. He knows, and the worker knows, that this is against the safety rules; and so the foreman will say,

"Joe, don't use that machine without wearing your goggles. How many times have we got to tell you it's against the rules?"

Joe will probably put on his goggles, but only because he has to — not because he wants to; and he's likely to make the same mistake again, particularly if the foreman isn't around.

But suppose our foreman thinks a minute before he talks, and then talks in terms of "you" not "I." Then he might say,

"Joe, in order to protect your eyes and avoid a painful accident, wear your goggles when you use that machine, will you?"

Here the foreman has talked to Joe about something Joe wants. He has avoided a negative attitude of criticism and sells him on something they both want. The result is a better feeling toward the foreman by the worker, and he is much less likely to break this rule again.

We neglect to sell when we talk to men of the wrong things they are doing before we speak of the right way. Of course, it is quite human to make this mistake. It is made everywhere; but a little thought reminds us that while it is the most natural thing in the world to talk to men about things that are wrong the instant we see them happen, the result is that the worker feels

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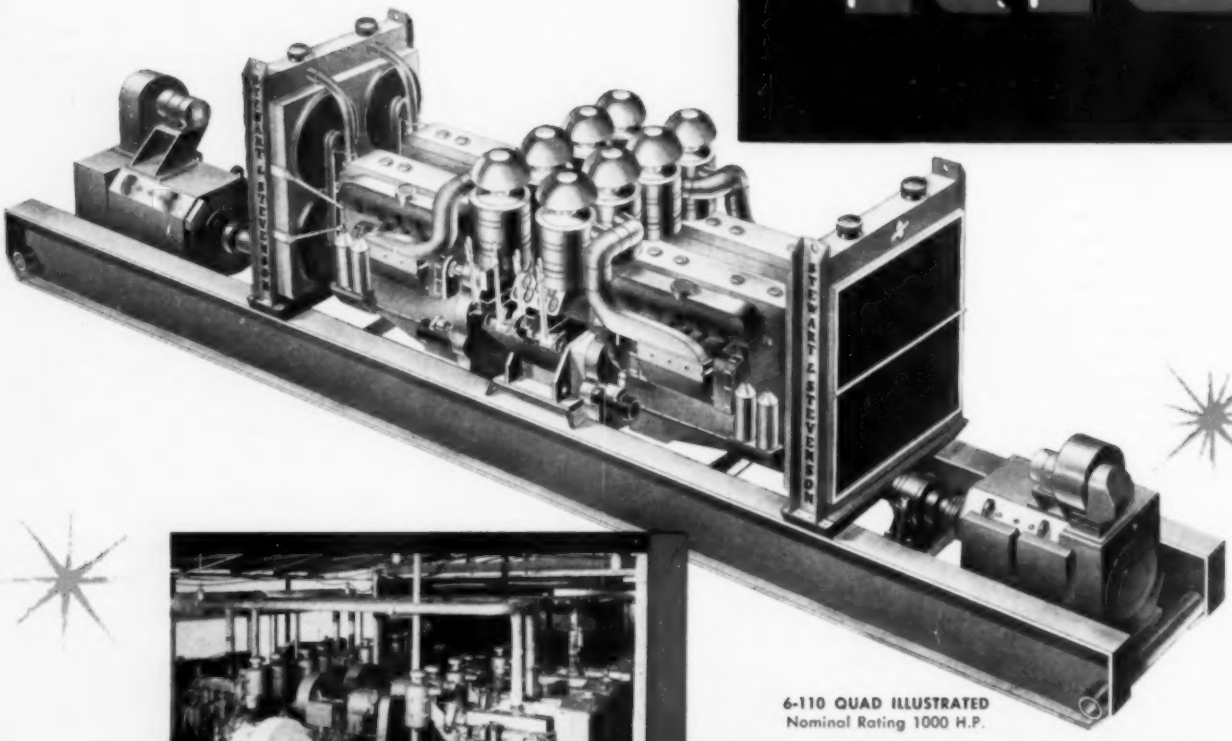

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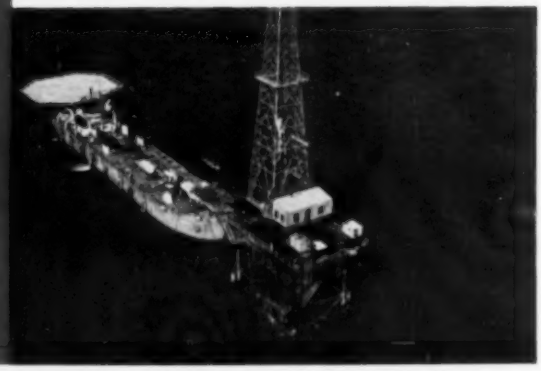

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we are criticizing him rather than trying to help.

When our problem is to convince a man that he should do willingly what we want done, we get better results when we talk to him in terms of what he gets out of it and how the idea will benefit him, before talking about the thing that we want done.

So it pays to stop for a minute and completely put ourselves in the other fellow's place. When we do this, we don't just pay lip service to the idea of making the other fellow feel important, but we get down to brass tacks.

Don't Argue — If You Win, You Lose!

Several years ago I traveled Cape Cod selling carload lots of coke to the fuel dealers in that area. On my first call on one of the dealers down there I told him the story about my product and all the benefits that would be his when he bought. After I had finished, he looked at me with a somewhat fishy eye and said something about "horse feathers on very small horses."

Being very sure of myself, I arose to the occasion and very soon we were in a first-class argument.

I won the argument.

But, I didn't get an order.

I have proved again what thousands of others have proved before — "Don't Argue: If You Win, You Lose!" It is impossible to win an argument and really come out a winner. Benjamin Franklin once said, "If you argue you might achieve a victory sometimes; but it will be an empty victory because you will never get a person's good will."

Of course, if you are the boss, if you have the authority and use it, or if you know all the facts, you can seem to win an argument; but you will probably not gain a reputation as a human fair-minded supervisor.

By arguments we mean disputes — not discussions.

It is necessary to discuss and reason with workers every day, but our conversation ought to be kept on a reason basis and not fall into the unfriendly area of dispute. As someone has neatly put it, "When we discuss things with each other, we ought to avoid the acute angle."

This is very simple and obvious. But let's remind ourselves that successfully dealing with people is so simple that *it isn't obvious to the average person.*

Almost every man that ever became a supervisor of people has been told, "Avoid arguments," but still we find ourselves getting into arguments time and again when our intentions were only to discuss or reason. Why? Perhaps because we fail to make the following suggestions a part of our standard equipment:

Let's Watch Our Voice

Inscribed on a bronze tablet at West Point Military Academy are these words:

"*. . . It is possible to impart instruction and to give commands in such a manner and such a tone of voice as to inspire in the soldier no feeling but an intense desire to obey, while the opposite manner and tone of voice cannot fail to excite strong resentment and a desire to disobey.*"

One of the smartest things that a supervisor can do for himself is to have his voice recorded and hear just how he sounds. Some of us will get a real shock! Many supervisors who habitually bark at workers, who talk out of the corner of their mouth, or give orders in a harsh, unfriendly tone, will be greatly benefited just by hearing how they sound.

Let's remember that we sell with our voice. Our voice is part of us, and how we use our voice in talking is extremely important.

Let's Agree Before We Disagree

One of the most sensible and easy-to-use methods of avoiding arguments and keeping discussions on a friendly basis is to "agree before we disagree" — what in the language of the salesman is called the "Yes, but . . ." method.

How do we agree before we disagree?

When someone makes a statement with which we cannot agree, or when a person says something to us in an unfriendly or upset manner, or when they object to something which we propose, let's not rush in to verbally defend our point of view until we —

1. Assume a calming and thoughtful attitude,
2. Ask a short question which requires no answer,
3. Make an assuring statement that we heard and understand and respect the speaker's point of view.

These three things when used together in this way have a powerful effect in avoiding arguments and keeping talk on a reason level.

How to Use These Suggestions

Henry Drummond in his book, "The Greatest Thing in the World," remarks, "The World is not a playground; it's a schoolroom. Life is not a holiday, but an education."

Doesn't that apply in the application of these rules?

What makes a baseball player? Practice! What makes us really good at being human on the job? Practice and more practice!

Not one of these suggestions is new or untried, although some of us have neglected to use some of them. Perhaps the first time we try some of these suggestions they may not work out to our complete satisfaction. That doesn't mean they are not good or practical. It simply means that we have not yet welded them into our own personality.

If we don't like them, perhaps it's because we haven't made them our own to a sufficient degree.

It may be something like the fellow who walked up to Billy Rose the second year of the World's Fair in New York and said, "Mr. Rose, I have a marvelous new act. It's wonderful! It's colossal! I climb up a high ladder, 250 ft up, then I dive and land right in the middle of this small bucket of sand."

Billy Rose looked at him, and at the bucket of sand, and said, "Brother, you're crazy!"

The fellow said, "No, I'm not crazy. I can really do it."

So they built him a ladder; he put on his tights, climbed 250 ft up the ladder, turned, and dived — and sure enough, he landed right in the middle of the bucket of sand.

Rose was delighted and said, "That's wonderful! That's marvelous! I'll buy that act. I'll give you $250 a week for it."

The fellow hesitated, shook his head reluctantly and said, "Nope."

"Well," said Rose, "the budget is stretched almost to the breaking point, but I'll give you $500 a week for that act."

The fellow sighed and said, "Nope. As a matter of fact, this is the first time I tried that, and I don't like it!"

So it may be with us. We may not like some of these suggestions until we practice using them.

Here is an idea for practice. Have each one of these suggestions typed out on a three by five card. Then take 10 minutes to memorize them. Be sure to memorize them thoroughly. Then take the first one, LEARN TO LIKE PEOPLE, and practice it for three days. Work with it consciously and conscientiously for three full days, and then go to the second one, BE GENEROUS WITH HONEST PRAISE. For a three-day period take every opportunity to compliment and praise where you can sincerely and honestly, and so on until you have covered all the suggestions.

It may be well to set these cards up on your desk where you can see them or they may be inside the windshield of your car, or the bathroom mirror; but get them up there where they can be seen as often as possible.

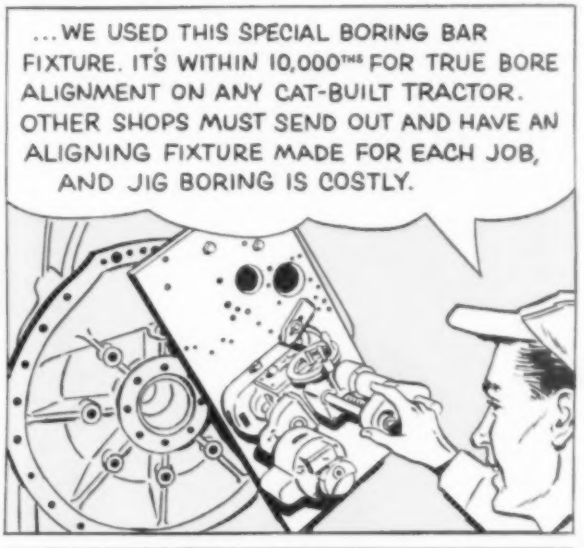
The psychologists says, "If you do a thing 33 consecutive times, it becomes a fixed habit."

There is nothing new in this suggestion, but it works. ★ ★ ★

THE CASE OF THE

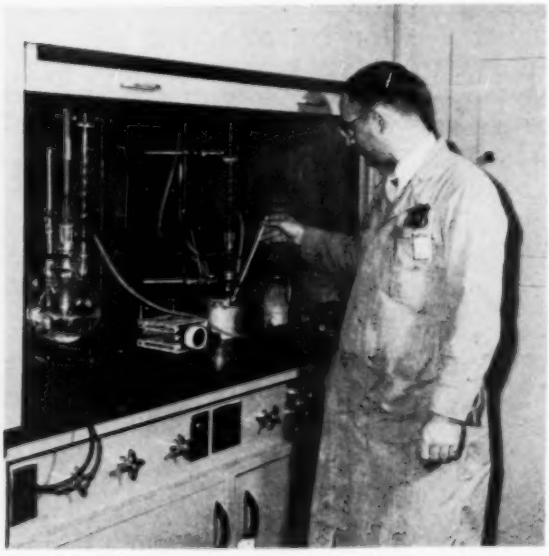
TOOL THAT BUILDS EXTRA WORKING HOURS

WE'RE SET UP WITH DIFFERENT WORK AREAS, AND WITH SPECIAL TOOLS AND EQUIPMENT FOR DIFFERENT JOBS.
IT'S A NEAT LAYOUT, ALL RIGHT!


...WE USED THIS SPECIAL BORING BAR FIXTURE. IT'S WITHIN 10,000™s FOR TRUE BORE ALIGNMENT ON ANY CAT-BUILT TRACTOR. OTHER SHOPS MUST SEND OUT AND HAVE AN ALIGNING FIXTURE MADE FOR EACH JOB, AND JIG BORING IS COSTLY.

CATERPILLAR*
*Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.
CAT CARE FOR LONGER WEAR
LET ME HELP KEEP YOUR CAT* EQUIPMENT ON THE JOB!
Caterpillar Tractor Co., Peoria, Illinois, U.S.A.

Besides Phillips Chemical Laboratories (foreground) and Sales Service Laboratory (right), the Research Center also contains (background) a new power house, an Automotive Laboratory, and more than 20 small pilot plants.



Numerous modern safety features in Chemical Laboratories include special built-in fume hoods to allow safe handling of toxic or flammable materials.

Marlex plastics semi-works plant is among developmental facilities at the Center. Completing its first year of operation, this plant supplied a substantial volume of Marlex 50 polyethylene plastic to plastics fabricating industry for evaluation in consumer product uses.

30 Years of Growth Puts Phillips Center Among Top Research Organizations

PHILLIPS PETROLEUM COMPANY'S Research Center near Bartlesville, Oklahoma, recently expanded, is an outgrowth of more than 30 years of Phillips activity in the field of research and development.

Newest additions are large, modern chemical laboratories, and a sales service laboratory for plastics testing and evaluation.

Providing a working area for more than 800 Phillips employees, the Research Center is situated on a 270-acre "campus" of extensive and diversified facilities where groups of highly trained specialists are engaged in a broad range of activities.

They represent many fields of petroleum and related technology, including the development of new products, processes, and methods, as well as the improvement of existing ones, in the fields of petroleum exploration and production, synthetic rubber, aviation gasoline, motor fuels, carbon black, liquefied petroleum gases, plastics, lubricating oils, ammonia and ammonia-based fertilizers, specialty chemicals, scientific instruments, radiation chemistry, and rocket propellants.

These activities vary in scope from basic research at the frontiers of fundamental scientific knowledge to semi-commercial pilot plant operations. Some studies are conducted in cooperation with other industrial organizations, with universities, and with government agencies.

The work of Phillips research and development department is carried on in six divisions, and the research division is established in the new chemical laboratories building as well as in some other facilities at the Research Center. Pilot plant and semi-works facilities at the Research Center are operated by the department's process development division. Other divisions are patent, market development, atomic energy, and rocket fuels. The sales service laboratory is operated by Phillips Chemical Company's plastics sales division.

The chemical laboratories building, providing working space for 325 Phillips employees, is a tribute to the important achievements of Phillips scientists and expresses the company's faith in their ability to use science creatively for the discovery of beneficial new products and processes.

The three-story, L-shaped structure, completed late in 1956, contains approximately 90,000 sq ft of floor space. It was designed by the architectural and engineering group, Giffels and Vallet, L. Rosetti, Detroit, Michigan, and was built by Manhattan Construction Company of Muskogee, Oklahoma.

Main laboratory areas are on the upper two floors on both sides of central six-foot corridors. Laboratories are equipped with fireproof steel furniture finished in chemically resistant enamel. The building also houses a technical library, a cafeteria, conference rooms, offices for supervisory personnel, shipping and receiving areas, photographic dark rooms, and air conditioning and heating equipment.

Modern safety features installed in the building include enclosed stairways, fire-hose cabinets, a fire-alarm system, multiple exits from all laboratory areas, fume hoods to handle toxic or flammable vapors, safety showers, and portable equipment such as extinguishers, gas masks, and face shields.

Phillips research and development organization has made

Latest additions are Chemical Laboratories and Sales Service Laboratories buildings . . . both well designed and equipped with modern and unusual tools . . . More than 800 persons work together to push back scientific frontiers . . .

numerous discoveries of great value to its credit. Its scientists, engineers, and technologists have played an important part in the growth of the company's assets to more than $1⅓ billion.

The sales service laboratory is designed especially to provide facilities that enable Phillips technologists to develop new applications for its Marlex* polyethylene plastics, to aid customers in the plastics industry in the fabrication and use of this plastic, and to evaluate newly developed Phillips plastics.

The one-story structure, containing 16,000 sq ft of floor space, is in the same style as the chemical laboratories, and was designed and constructed by the same architectural and construction firms.

A major part of the sales service laboratory is devoted to the equipment needed to shape, mold, and extrude the plastics which are being tested. A separate, large laboratory workshop is provided for this phase of the program, and here are located the several intricate machines, some very large size, on which this work is performed. From these machines such items as fibers for fabrics, film for packaging, houseware such as bowls, cups, wastebaskets and many other items can be made.

Among the outstanding features incorporated into the building are the high and low temperature testing rooms. Here, tests can be made on plastics at temperatures as low as 100 F below zero, and as high as 180 F above zero. These temperature tests are necessary in determination of the uses of plastics.

There are also more than 20 buildings of special design housing experimental facilities in which new processes are tested and engineering information is obtained for the design of commercial plants.

An example of such work at this location is the Marlex polyolefin semi-works plant which has completed its first year of operation. It has supplied Marlex materials to the plastics industry for application testing in numerous consumer and industrial products. Another example is a complex installation for the evaluation of aviation jet engine fuel performance characteristics. Conditions simulating those encountered during supersonic flight and at altitudes up to 100,000 ft can be obtained.

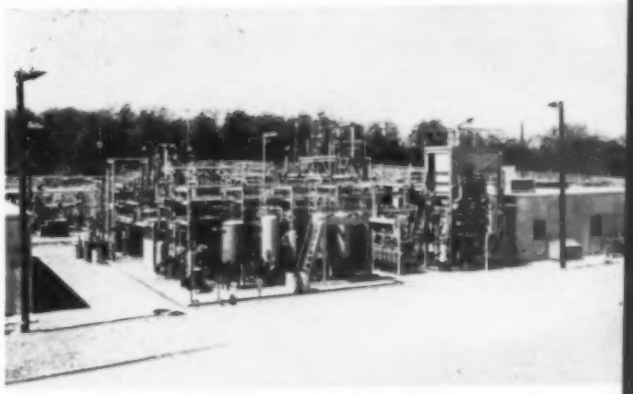
At the nearby automotive laboratory, extensive full-scale engine tests are conducted to develop Phillips automotive fuels and oils to assure superior performance of these products in passenger cars, trucks, buses, and tractors. Equipment here includes modern passenger car, diesel truck, and special test engines. One engine can be equipped with radioactive parts to study the wear-reducing properties of motor oils.

A new central powerhouse provides the Research Center with steam and refrigerated water through an underground piping system. Air conditioning equipment has 700-T capacity.

Landscaping at the Research Center will be completed soon, and an underground sprinkler system will water the lawn. It will use pipe made of Marlex polyolefin plastic.

The new facilities at Phillips Research Center are an important addition to one of the nation's foremost research organizations. Company management believes that productivity of Phillips scientists here will contribute greatly to the usefulness and efficient utilization of the world's petroleum and mineral resources. ★ ★ ★

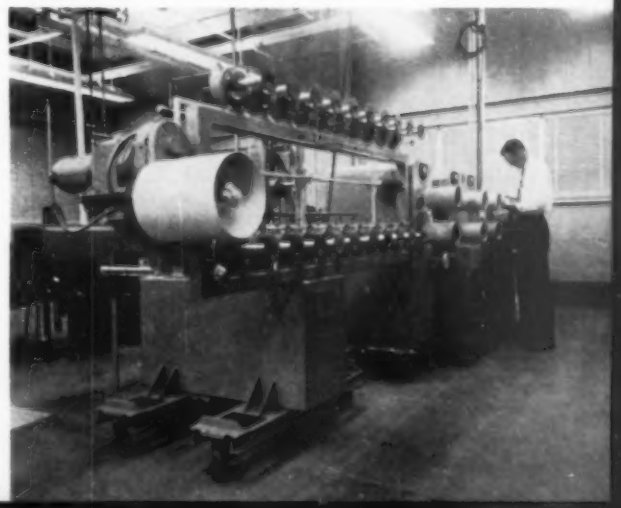
*A trademark for Phillips family of olefin polymers.



Typical of the many laboratories in the Chemical Laboratories building at Phillips Research Center, is this portion of a laboratory in the analytical section.

Through fundamental research, traveling many routes before a hopeful idea reaches the development stage, such a small-scale array of fragile glass tubes and vessels may some day emerge into a new plant, producing some yet unknown marvel of chemistry rivaling the new Marlex plastics.

Marlex 50 polyethylene is readily processed into monofilaments (fine thread) and multi-filaments. A full range of filament colors is obtained by compounding suitable pigments with the resin before extrusion.



BENDIX OFFERS A COMPLETELY MODERN INDUSTRIAL ENGINE MAGNETO

UNMATCHED DESIGN FEATURES

Metal Encased

Fully Ball Bearing Equipped

Pivotless Aircraft Type Breaker

Impulse Coupling Provides for Complete Adjustment of Lag Angle and Lug Position

High Output at all Operating Speeds

Metal High Tension Outlet Plate and Feed-through Condenser on Shielded Magnetos

The reputation of Bendix* in the field of ignition is truly unmatched. From the history-making flight of Lindbergh to today's fastest jets, the aviation industry has always looked to Bendix for the latest and most efficient ignition equipment. Likewise in industrial ignition Bendix has set new standards of performance in applications ranging from small outboard motors to the largest industrial engines.

That's why the introduction of this new Bendix S-400 series of magnetos is of such great importance. Here is a magneto that incorporates all of the improvements and refinements of modern ignition design.

Built to aircraft precision standards the new S-400 series is especially rugged so as to deliver trouble-free operation during long periods of service.

It is available in both four- and six-cylinder flange-mounted models in weatherproof, unshielded and radio-shielded versions.

For the important jobs where continuous top performance is a must, the new Bendix S-400 series magneto is the logical choice. Why not write today for complete details and specifications of this modern industrial engine magneto.

SCINTILLA DIVISION OF BENDIX AVIATION CORPORATION, SIDNEY, N. Y.
Export Sales and Service: Bendix International Division, 205 East 42nd St., New York 17, N. Y.

*TRADEMARK

Scintilla Division
SIDNEY, N. Y.

Bendix
AVIATION CORPORATION

fourth of a series

Ohio State Presents Split Course

Four-week program is divided into two weeks in two successive years so key executives can attend without long absence

William R. Davidson

LATE every summer a group of executives from a variety of companies assembles in Columbus on The Ohio State University campus to begin a four-week Executive Development Program. Actually, the four-week program involves participation in two different years. Executives who begin the program in 1957 will have two weeks of work this summer and will return in 1958 for the second half of their work. The program has been planned in this manner so that companies could allow key executives to participate, without having to provide a replacement for them during a protracted absence.

The Executive Development Program is sponsored by The College of Commerce and Administration of OSU in cooperation with the Ohio Manufacturers' Association, as an educational service to the business community. It was planned in response to expressions of need for a course that goes beyond the work that can be done by the individual company to develop attitudes and skills demanded of executives in policy level positions.

Executives have much to gain from participation in such a program, away from the pressures of day-to-day operating problems, under the direction of outstanding seminar leaders with teaching and business consulting experience, and in company with executives from a variety of industries.

Executive Development Program supplements individual company training or development programs by providing executives with the opportunity—

1. To add to their knowledge of tools and techniques which are required to handle administrative problems in an effective manner;
2. To approach and analyze various types of problems from a company-wide rather than from a personal or departmental point of view;
3. To enlarge their comprehension of the influences of the economic and social environment in the area of business administration; and
4. To acquire information that will be communicated to other non-participating executives in the registrant's company, through association and training.

Enrollment in each class is limited to 40 executives. In order to encourage a maximum of participation by each individual, the whole group is divided into two sections of 20 registrants each.

Subject matter in the various courses is presented with a view to stimulating the thinking of those in attendance. This is done through guided discussion, often involving the use of cases or problems. Practical business situations at the administrative level are approached from a variety of points of view. Various possible courses of action are evolved from group discussions and are evaluated. There is no attempt to provide definite answers to highly specific questions in types of situations where alternatives are usually available. In this manner, it is hoped that each participant may gain a broader perspective that will assist him in formulating plans and making decisions which are best suited to particular situations that he may encounter in his own company.

Registrants are provided with course outlines, mimeographed case and problem materials, and suitable texts. Assignments are made from day to day and are studied in advance of class meetings so that all participants have a common background with which to enter the discussions.

Faculty personnel are available at various times throughout the day for informal discussions of topics that have stimulated interest for further consideration.

During the first year of participation, executives are enrolled in four courses: General Administrative Management; Managerial Economics; Marketing Management, and Managerial Accounting.

Second year offerings include four more advanced courses: Personnel Management and Industrial Relations; Financial Management; Business Forecasting and Planning, and Government Regulation of Competitive Business Enterprise.

All class meetings are held in the new Ohio Union Building. This building is completely air-conditioned and is very comfortable during the summer sessions.

Registrants are housed at Baker Hall, a large, modern men's dormitory, near the Ohio Union Building. Private rooms are available for all registrants.

In general, it has been found that the program has high educational value for:

1. Executives who are presently in top management positions and who wish to broaden their perspectives.
2. Middle management personnel who have made unusual progress and who are slated for promotion to top management positions within the foreseeable future.
3. Major executives in specialized staff positions such as research, personnel, accounting, etc., where it is believed that they can benefit appreciably from a discussion of prob'ems from a company-wide point of view.

Registrants have come from all types and kinds of companies. Many have been presidents and vice presidents.

Cost of the two-week session in the first year of the program is $500 per enrollee. This includes the total expense of tuition for the class sessions, all supplies and books, housing and meals. The 1957 session will be held August 25 to September 7. ★ ★ ★

Mr. Davidson is director of Ohio State University Executive Development Program, Columbus 10, Ohio.

The "Heart" Of This BS&B

Is The New "COLD-FRAC"* AMMONIA ABSORPTION REFRIGERATION UNIT!

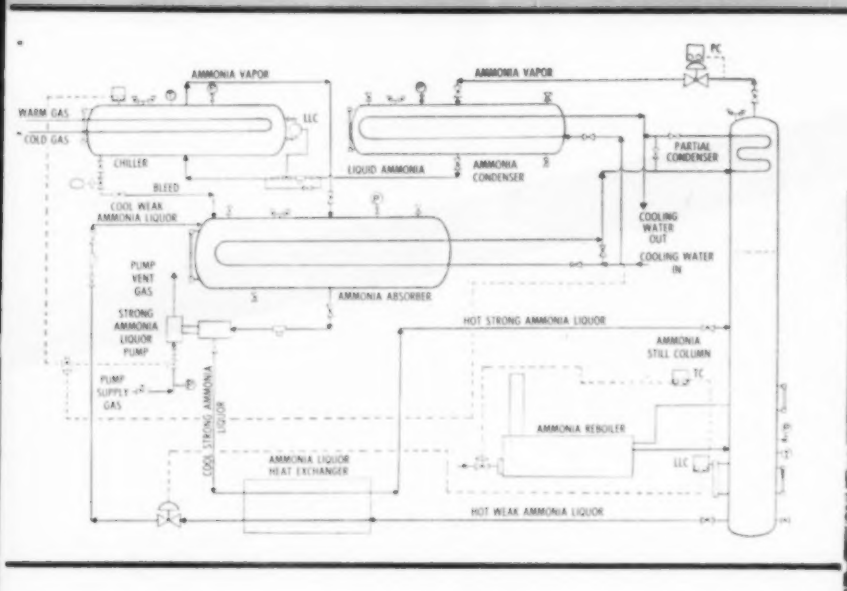
Ammonia Absorption Refrigeration Yields Low Dew Point Gas And Salable Liquid Hydrocarbons

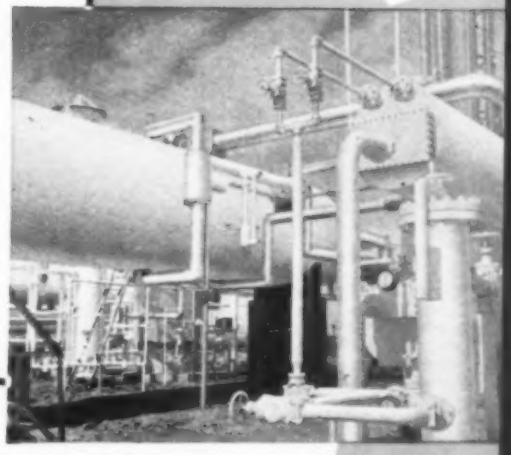
Early this year, Excelsior Oil Corp. (a subsidiary of Kansas-Nebraska Natural Gas Company, Inc.) put a new gas gathering plant on stream at Tyrone, Oklahoma. This plant, employing the new BS&B "COLD-FRAC" AMMONIA ABSORPTION REFRIGERATION Unit, is located on a major gas transmission line and was entirely designed, manufactured and constructed by BS&B on a "turnkey" basis. Here, in brief, are the important facts:

EFFICIENCY
OVER 60 YEARS
BS&B
RELIABILITY
ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

Your BS&B Man will be glad to give you detailed information on the new BS&B "COLD-FRAC" Ammonia Absorption Refrigeration Unit. Or, you may write to...

"Turnkey" Gasoline Plant...





THE OBJECTIVES:

1. To Achieve Maximum Dehydration Of The Gas Stream.
2. To Lower Hydrocarbon Dew Point To 0° F.
3. To Economically Extract Maximum Amount Of Salable Liquid Hydrocarbons Without Lowering Gas BTU Value Below Acceptable Limits.

The Company asked BS&B Engineers to analyze the objectives, and to recommend a suitable type plant.

THE RESULTS:

The low temperature plant was built "turnkey" by BS&B, incorporating Ammonia Absorption Refrigeration. This resulted in low water dew point, positive hydrocarbon dew point and the recovery of salable liquid hydrocarbons.

Ten Advantages Offered By BS&B "COLD-FRAC" Ammonia Absorption Refrigeration Units:

1. **Entirely Self-Operating.** Automatically Adjusts to Load Changes.
2. **Low Initial Cost.** Unit Is Entirely Skid-Mounted Except Ammonia Reboiler. Outside Construction — No Buildings Required.
3. **Low Cost Maintenance.** Liquid Pump Is the Only Moving Part.
4. **Operating Costs Vary** in Direct Proportion to the Load.
5. **Lower Operating Temperatures** Do Not Materially Decrease Capacity.
6. **Completely Closed System.**
7. **Chiller "Slop Over" of Liquid Refrigerant Causes No Problem.** (There is no compressor to cause worry about liquids in the suction.)
8. **Oil Lubrication Eliminated.** No Oil-Refrigerant Problem.
9. **Vibration Free.** No High Speed Reciprocating Machinery to Mount.
10. **Experts Are Not Required** to Operate and Maintain the Unit.

OTHER APPLICATIONS

BS&B Ammonia Absorption Refrigeration Units are applicable to any process that requires temperatures below ordinary atmospheric level, including all steps in the complete production cycle from the lease through the central plant to the refinery.

These units are constructed for heavy duty, continuous 24 hour-per-day, 365 day-per-year operation. Available in eleven standard sizes—with nominal capacities of up to 200 tons—these units have been designed to provide trouble-free, completely automatic operation under all conditions with minimum maintenance expense. Units larger than 200 tons in size offered on request.

* "COLD-FRAC" is a trade-mark of Black, Sivalls & Bryson, Inc.

BLACK, SIVALLS & BRYSON, INC.

Oilfield Equipment Division, Dept. 1-C6

P. O. Box 1714 Oklahoma City, Okla.

Management Personals

Garry Owen was elected a vice president of The Arabian American Oil Company. He will make his headquarters in Dhahran, Saudi Arabia, and will serve as Aramco's representative in discussions on company matters with the Saudi Arab Government.

Garry Owen

R. E. Nelson

Roy E. Nelson was elected vice president of the American Gilsonite Company. He will continue as manager of production. Nelson joined American Gilsonite in January 1949, coming from the Standard Oil Company of California. He holds BS and MS degrees from Massachusetts Institute of Technology.

John M. Snook, formerly regional manager for the Dixie Cup Company in Central America and the Caribbean area, was elected executive vice president and general manager of Consolidated Cuban Petroleum Corporation.

E. M. Caldwell was promoted to manager of taxes and governmental reports in the comptrollers department of Magnolia Petroleum Company. **B. N. Maples** was named assistant manager of taxes and governmental reports. **W. H. Rushing** was made section head.

Dr. Lawrence Dumas is assistant medical director in Dallas, Texas, working with **Dr. Robert J. Potts,** Magnolia's medical director.

John L. Firmin, safety supervisory of the Ohio Oil Company's products distribution department, is the new secretary of the petroleum section of the All-Ohio Safety Congress.

Vernon R. Schopp was appointed coordinator of communications services for the Standard Oil Company (Indiana). Schopp joined Standard in 1926 at St. Joseph, Missouri, and since 1946 has been assistant to the corporate secretary at Chicago, Illinois. He is a graduate of the University of Nebraska.

George Magurean, process engineer with the Electronic Industries Division, Consolidated Electrodynamics Corporation, was elected president of the American Electroplaters' Society, Los Angeles Branch.

Graham F. Towers is chairman of the board of British Petroleum Company (Canada) Limited, the Canadian member of the international BP group. Towers, who was until 1954 governor of the Bank of Canada, is a member of the Canadian Committee of the Hudson's Bay Company, and includes in his directorships the Canada Life Assurance Company, Canadian Investment Fund Limited and Bell Telephone Company Limited.

Walter Ziegler was elected to the post of executive vice president of Ryan Consolidated Petroleum Corporation. Ziegler, company vice president for the last six years, replaces **Seymour G. Hootkins,** who recently resigned to re-enter the oil business as an independent operator.

Dr. Kenneth Merle Watson, former vice president of the Pure Oil Company, was appointed to the staff of Illinois Institute of Technology, Chicago. He will teach and do research in the fields of kinetics and thermodynamics in the chemical engineering department, beginning September 1.

William K. Warren was elected president of the International Petroleum Exposition in Tulsa, Oklahoma, succeeding the late W. G. Skelly, who served as head of the world's largest industrial exposition for over 30 years. Warren is chairman of the board and chief executive officer of the Warren Petroleum Corporation and a director of Gulf Oil Corporation.

George C. Beaury was appointed vice president and treasurer of Blanco Oil Company. **James M. Gaines** was named vice president, **Howard R. Branch,** secretary, and **John H. White,** assistant secretary. Members of the board are **Hugh Halff Jr.,** Beaury, **Arnold S. Askin,** Gaines, and Branch.

Joseph A. Metzger was named corporate manager of personnel relations of Seaboard Oil Company. He was formerly personnel manager of the Armour Research Foundation.

"Citations of Service" given in recognition of outstanding service by the

Paul Benedum

R. G. Strong

American Petroleum Institute Division of Production, will go to **Paul Benedum,** Hiawatha Oil Company, Pittsburgh, Pennsylvania; **R. G. Strong,** Natural Gas Pipeline Company of America, Chicago, Illinois; **John Buckwalter,** Ryder Scott Company, Wichita Falls, Texas; and **W. B. Simpson,** Hope Natural Gas Company, Clarksburg, West Virginia.

John Buckwalter

W. B. Simpson

J. S. Boylan, Continental Oil Company, Bartlesville, Oklahoma, received a Certificate of Appreciation at the mid-year meeting of the safety and fire protection committees of the API.

I. J. Anderson

I. J. Anderson was elected vice president of Gulf Interstate Oil Company, subsidiary of Gulf Interstate Gas Company. Anderson has been division manager of Gulf Interstate's production division in Lafayette, Louisiana.

Archie D. Gray and **Dr. Hollis D. Hedberg** were elected vice presidents of Gulf Oil Corporation. Gray, general counsel of Gulf since February 1956, will become vice president and general counsel. Hedberg, exploration coordinator since June 1953, will be vice president, exploration.

Charles C. Jarchow, president and a director of American Steel Foundries, was elected to the board of directors of Universal Oil Products Company. He also is a director of Griffin Wheel Company, Griffin Steel Foundries, Ltd., Illinois Bell Telephone Company, Pipe Line Service Corporation, Diamond Chain Company, Harris Trust and Savings Bank, Chicago, Illinois, and the Illinois Institute of Technology. **Guy E. Reed,** prominent retired Chicago banker and civic leader, had declined re-election to Universal's board for reasons of health. Reed had served as a director of UOP since 1944.

DEATHS

G. Stewart Brown, 50, manager of the public relations department of Standard Oil Company of California, died April 11. He had been in ill health for several months.

Vernon F. Palmer, vice president in charge of operations for the Union Gas System, died in Independence, Kansas, on April 7, following a brief acute illness from heart complications.

Leonid A. Umansky, 66, retired manager of Systems Application Engineering for the General Electric Company, died April 3. He was awarded the Thomas A. Edison Medal for "his outstanding contributions to the electrification of industry" and the Coffin Award, General Electric's highest tribute for engineering accomplishments.

Edward Boll, vice president and sales manager of Everlasting Valve Company, Jersey City, New Jersey, died suddenly on March 11.

J. E. Regent, formerly Rocky Mountain area manager of Sun Oil Company, died recently.

Bruce Arbogast, founder of "The Oil News," Albuquerque, New Mexico, died recently after a long illness.

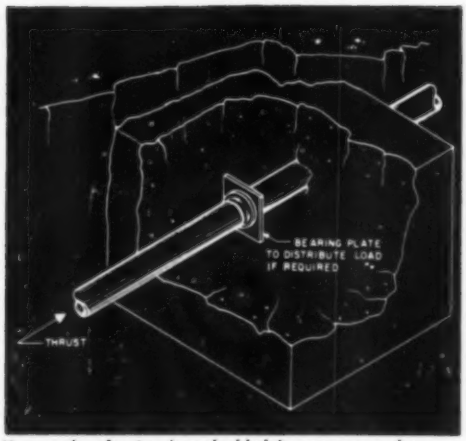
Byrd Lynch, 22, died recently from suffocation. He received an overdose of gas fumes from an open hatch on a tank of a Voss Oil Company well at Newcastle, Wyoming.

George P. Bourke, 60, well known in oil and uranium activities in Wyoming, died from an accidental gunshot wound.

Jasper Sloan, 61, died recently. He was employed by Halliburton Oil Well Cementing Company.

Forest G. Vergne, 46, died at his home in Midwest, Wyoming. He was district clerk for Pan American Petroleum Corporation.

Close-up of TUBE-TURN Anchor Forging after butt-welding into 20" line.



How anchor forging is embedded in concrete and transmits pipeline thrusts to the structure.

Completed installation, showing reinforcing structure, ready for concrete.

Hold that line

with the new TUBE-TURN Welding Neck Anchor Forging*

Installing TUBE-TURN Anchor Forging in 20" gas line of Texas Gas Transmission Corp., near Eunice, La. Hubs are butt-welded to pipe ends.

High operating pressure, and expansion forces due to temperature change can team up to produce end thrusts in pipelines of 1,000,000 lbs. or more! Lines may be overstressed and expensive equipment damaged.

TUBE-TURN* Welding Neck Anchor Forgings provide an answer to this problem. Available for pipe sizes 6" through 36"... for operating pressures up to 1200 psig and temperature changes up to 90° F.

In writing for information, provide this data on your application: Size, wall thickness and material of matching pipe, design pressure and temperature, special requirements.

TUBE TURNS LOUISVILLE 1, KENTUCKY

A Division of National Cylinder Gas Company

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Chicago • Detroit • Atlanta • New Orleans • Houston • Midland Dallas • Tulsa • Kansas City • Denver • Los Angeles • San Francisco • Seattle

In Canada: Tube Turns of Canada, Ltd., Ridgetown, Ontario • Toronto, Ontario • Edmonton, Alberta

tt TUBE-TURN

*"TUBE-TURN" and "tt" Reg. U.S. Pat. Off.

Designer Drafts, Too

Allergies are blamed for many things but **Patricia Metcalfe** should be glad of hers — it brought her into the petroleum industry. She started out to be a fashion designer and found her way from there to the oil business.

Pat is one of nine children, born in Oklahoma and reared in Glendale, California. After attending Frank Wiggins Trade School with a two-year course in pattern design, Pat studied and later taught pattern-making and design at Hollywood Art Center School. This career was suddenly ended when her doctor told her "cutting dust" was causing her allergy.

After this disappointment, a friend came to her rescue suggesting that with her art and lettering background, she might enjoy drafting. She describes her new career as fascinating. She was with Honolulu Oil Corporation and now with Cyprus Oil Company and Bell Petroleum Company on a retainer basis. Her drafting work includes making cross-sections, contour maps, pipeline maps, in fact, any geological or engineering studies being worked on — as well as the usual land maps, graphs, charts, etc.

Patricia Metcalfe

"Chalk Talks," which she does with her sister, is one of Pat's pet outside interests. Her sister tells a Bible story to children while Pat illustrates by making chalk drawings. She has also made about 75 pictures for a Bible Study Course for children — "The Greatest Book in Pictures." Three years ago the board of directors of the Christian Released Time Education program in the Los Angeles City School System, voted to use her pictures and lessons. This year they have over 6000 children in their classes.

While in the world of fashion designing, Pat created the wardrobe for Miss California who later won the title of Miss America at Atlantic City, in 1946. She still designs her own outfits and hats.

A member of Desk and Derrick, Oil Map Association, and International Order of the King's Daughters and Sons, Pat also has time for ice skating, skiing, swimming, golf, sewing, cooking, travel, music, and spectator sports.

Expect 1500 at Meet

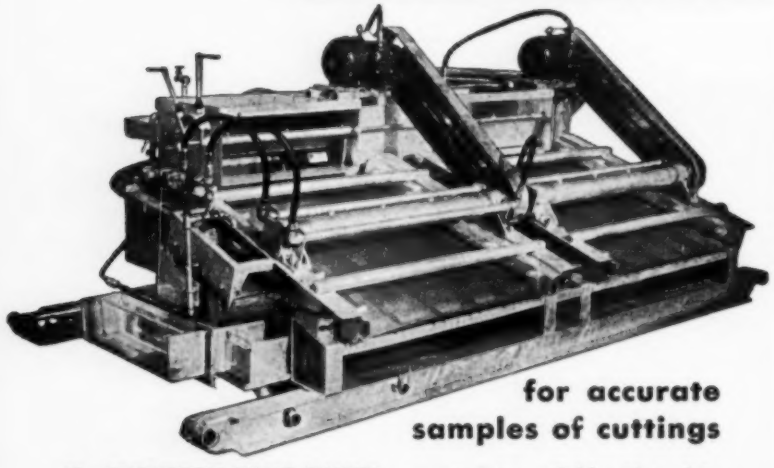
Desk and Derrick Club of Chicago, Illinois, expects some 1500 delegates and members to attend the Sixth Annual Convention of the Association, on August 30 and 31.

Headquarters have been established in the world's largest hotel, Conrad Hilton, which overlooks the lake, according to Emily Fairbanks, general arrangements chairman.

Edna M. Hurry, New York, immediate past president, is the keynote speaker.

Thompson

DOUBLE VIBRATING
SHALE SHAKER...and
SAMPLE MACHINE



for accurate
samples of cuttings

The THOMPSON SHALE SHAKER SAMPLE MACHINE offers the operator and geologist one of the best methods available for obtaining accurate foot-by-foot samples of well cuttings.

This THOMPSON DOUBLE VIBRATING SHALE SHAKER and SAMPLE MACHINE is specially engineered for off-shore barges or islands, deep wells, or wells using big volume and high pressure mud pumps. It is available either plain or galvanized, which makes it rust and deterioration-proof on off-shore or coastal duty

THOMPSON Shakers are famous for their highly efficient service at any depth or flow and for their economical first cost.

Make sure THOMPSON'S on the job for accurate samples and clean mud.

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THROUGH
SUPPLY STORES

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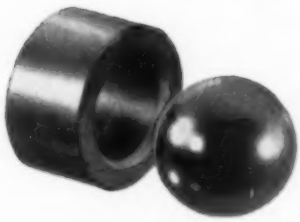
TOOL CO.
IOWA PARK TEXAS



REPORTS OF PERFORMANCE

from users during the past 16 years show that Kennametal* lasts 20 times longer than steel and 3 to 5 times longer than special and super alloys.

- A Texas producer reported sand abrasion forced a pulling job every 14 to 20 days. After 448 days on the job, Kennametal Balls and Seats showed no wear when well was pulled for other than valve job.

Kennametal wear parts in this Otis bottom hole regulator provide 12,000,000 closures under 1200 psi in sand-sulfide fluid. Used parts illustrated have already given 3,628,000 closures in six months service, from 7000 feet.

Kennametal API Balls and Seats are available at repair shops of most major pump manufacturers. Ask your service man to standardize on them. They'll cost you less in the long run. KENNAMETAL INC., Dept. PE, Latrobe, Pa.

*Kennametal is the Trademark of a series of hard carbide alloys of tungsten, tungsten-titanium and tantalum.

INDUSTRY AND
KENNAMETAL
...Partners in Progress

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

• Industry
• People
• News

The Trade PARADE

Ideco Rig Completed in Italy

Completion of the first of a series of twelve Ideco Super 7-11 drilling rigs — the largest ever built in Europe — heralded a new industrial era in the construction of heavy oilfield equipment in Italy, and an extension of the activities of Dresser Industries, Inc., of which Ideco is a subsidiary, into the Italian oil equipment and heavy machinery field. Plant of Nuovo-Pignone licensed manufacturers of Ideco products in Florence, Italy, was

the scene of special ceremonies marking the completion. Leading Italian industrialists and statesmen were present, including Ministers Tambroni and Bigorelli, Mayor LaPira of Florence, members of Parliament, Senators, and delegates from the Council of Shop Stewards. On the drilling platform of the huge Ideco-Pignone rig a benediction was given by Cardinal Elia dalla Costa, Archbishop of Florence.

G. W. (Jack) Walton, executive vice president of Ideco, Dallas, Texas, was present at the Florence ceremonies.

Electro-Tech in New Plant

Electro-Technical Labs., division of Mandrel Industries, Inc., has moved to its new plant in Houston, Texas. The new, half-million dollar plant encompasses more than 35,000 sq ft and will increase Electro-Tech's production capacity and engineering facilities.

Procon Addition Finished

Headquarters of Procon Incorporated have been expanded by a two-story addition adjoining the company's offices in Des Plaines, Illinois. Formed in 1950 to provide engineering, procurement, and construction services to the petroleum, petrochemical and chemical industries, Procon currently is building plants in Europe, Australia, Latin America, Canada, and the United States. Executive, sales and administrative engineering operations offices are located in the new building.

Welding Industry Leaders Honored at Annual Meeting

The American Welding Society honored five men with national awards at its annual meeting. Fred L. Plummer, director of engineering, Hammond Iron Works, was named winner of the Samuel Wylie Miller Memorial Award. This year's Adams Lecturer was DeWitt C. Smith, chief metallurgist, Harnischfeger Corporation, who was presented a certificate and honorarium upon the presentation of his special paper on the subject of the welding of ultra high strength steels.

Honorary membership in the Society was awarded O. B. J. Fraser, assistant manager, Development and Research Div., International Nickel Company. The 1957 Lincoln Gold Medalist was Jay Bland, project engineer, Engineering and Research Dept., Standard Oil Company (Indiana), and the National Meritorious Service Award went to A. N. Kugler, chief welding engineer, Air Reduction Sales Company.

Building Begins on Yale Plant

Construction has begun on the Yale & Towne Manufacturing Company's new $4,000,000 materials handling equipment manufacturing plant, and mid-continent parts depot in Forrest City, Arkansas. Located on a 35-acre plot, plant will have more than 157,000 sq ft of operating area. When completed this summer, the new structure will be the center of production for the complete lines of Yale hand trucks and Yale hand hoists.

Atomic Energy Plant Opened

A modern plant devoted entirely to peaceful uses of atomic energy has been completed by Tracerlab, Inc. in Waltham, Massachusetts. The $1,900,000 plant will house Tracerlab's East Coast laboratory, research and manufacturing facilities. Tracerlab's product line ranges from simple lead bricks for radiation shielding to complex process control systems using radioisotopes.

President W. O. Faxon said, "It is predicted that the nuclear instrumentation market alone will rise to a total of $135 million by 1963 (compared to $10 million in 1955) in response to an accelerated reactor building program as well as to new applications for atomic energy uncovered by research now in progress."

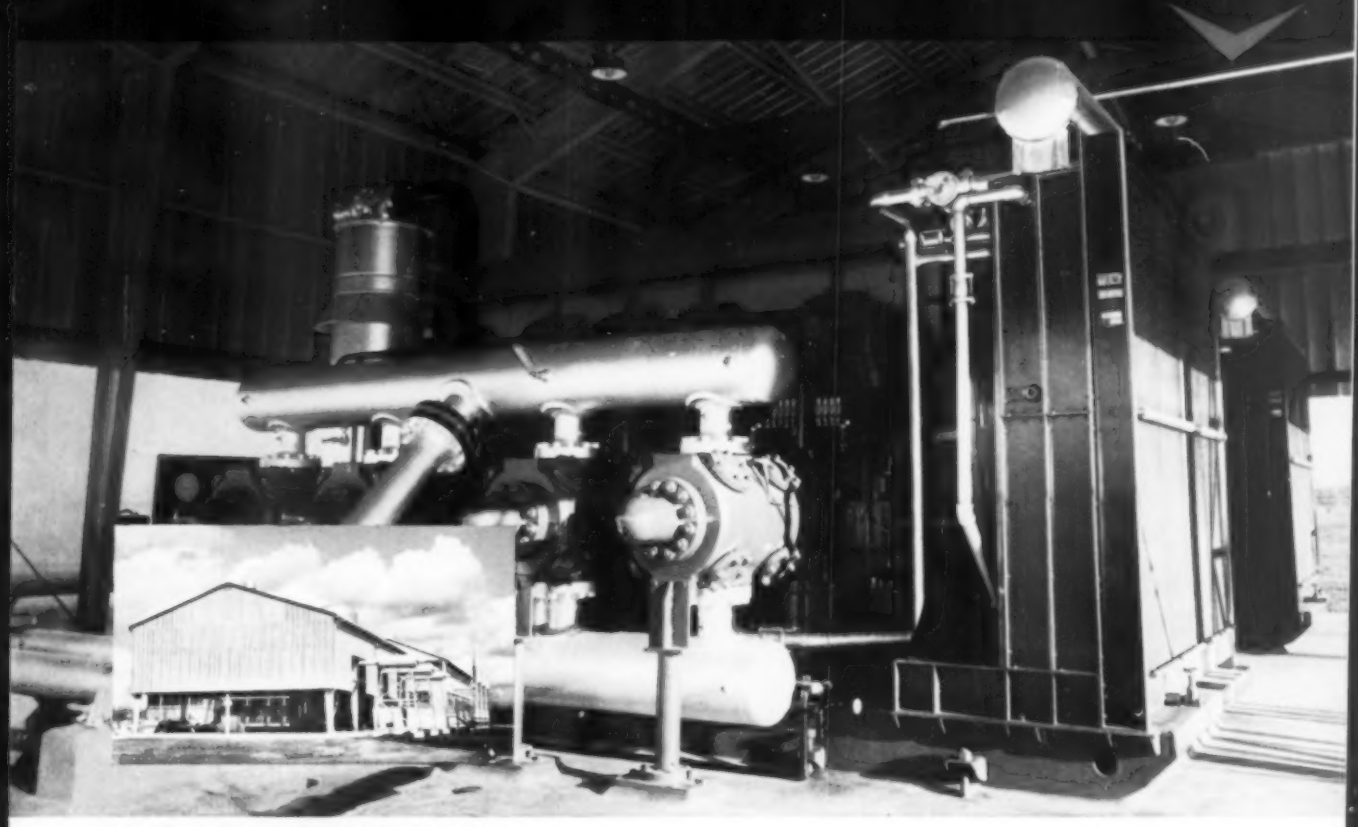
Scholarships Provided

Herb J. Hawthorne, Inc., Houston, Texas, is providing three continuing annual geophysical scholarships to deserving engineering students. The Cordie Hawthorne Scholarship will be administered by the Scholarship Program of the Student Membership Committee of the Society of Exploration Geophysicists, headquartered in Tulsa, Oklahoma. It will annually provide $750 toward tuition, laboratory fees, etc., in an American university for a student pursuing a career in geophysics. An additional annual grant of $700 by Hawthorne will be administered through the Canadian Society of Exploration Geophysicists, through their Committee on Education. It will provide financial assistance to two students of engineering in Canadian universities.

Chemical Firm Enlarges

Olin Mathieson Chemical Corporation's newly enlarged plant at McIntosh, Alabama, can turn out twice its previous production of chlorine and caustic soda. An $8,000,000 addition, it has boosted the plant's capacity to 250 tons of chlorine and 280 tons of caustic soda per day. The expansion includes barge loading facilities on the Tombigbee River, which extend the plant's effective marketing area to points on the Gulf Coast, eastern seaboard, and inland waterways. New portion of plant is light-roofed building at right.

BEAIRD-INGERSOLL-RAND Packaged Compressor Plant



SOUTHERN NATURAL GAS COMPANY's White Castle Supply Line Station, equipped with two Beaird-Ingersoll-Rand 10-SVG, 550 h.p. packaged compressors. Shown in inset is the Toca station where three 12SVG, 660 h.p. Beaird packaged compressors have been installed to supplement three large stationary units. Other sizes available from 120 to 660 h.p.

Economical Expansion —

PACKAGED UNITS ADDED TO STATIONARY COMPRESSOR INSTALLATION

SOUTHERN NATURAL GAS COMPANY's growing supply line systems are reaching toward the Gulf on both east and west sides of New Orleans. Pacing this expansion are two new packaged compressor installations boosting the increased gas volume to the main supply line station at Gwinville, Mississippi. The east side line is handled by the enlarged compressor station at Toca, Louisiana. Formerly equipped with three large stationary compressors, this plant has been expanded by adding three 12SVG 660 h.p. Beaird-Ingersoll-Rand packaged units. On the west line a new station at White Castle equipped with two 10SVG 550 h.p. units is offsetting the increased line pressure from Toca station and handling added gas volume.

Southern Natural selected packaged compressors for their expansion program as a result of their field experience. Package units have proved more flexible in service, were more economical to install, required less foundation work and when no longer needed can be almost wholly salvaged. Packaged compressor equipped stations have also been found to be easier and more economical to design for future horsepower additions.

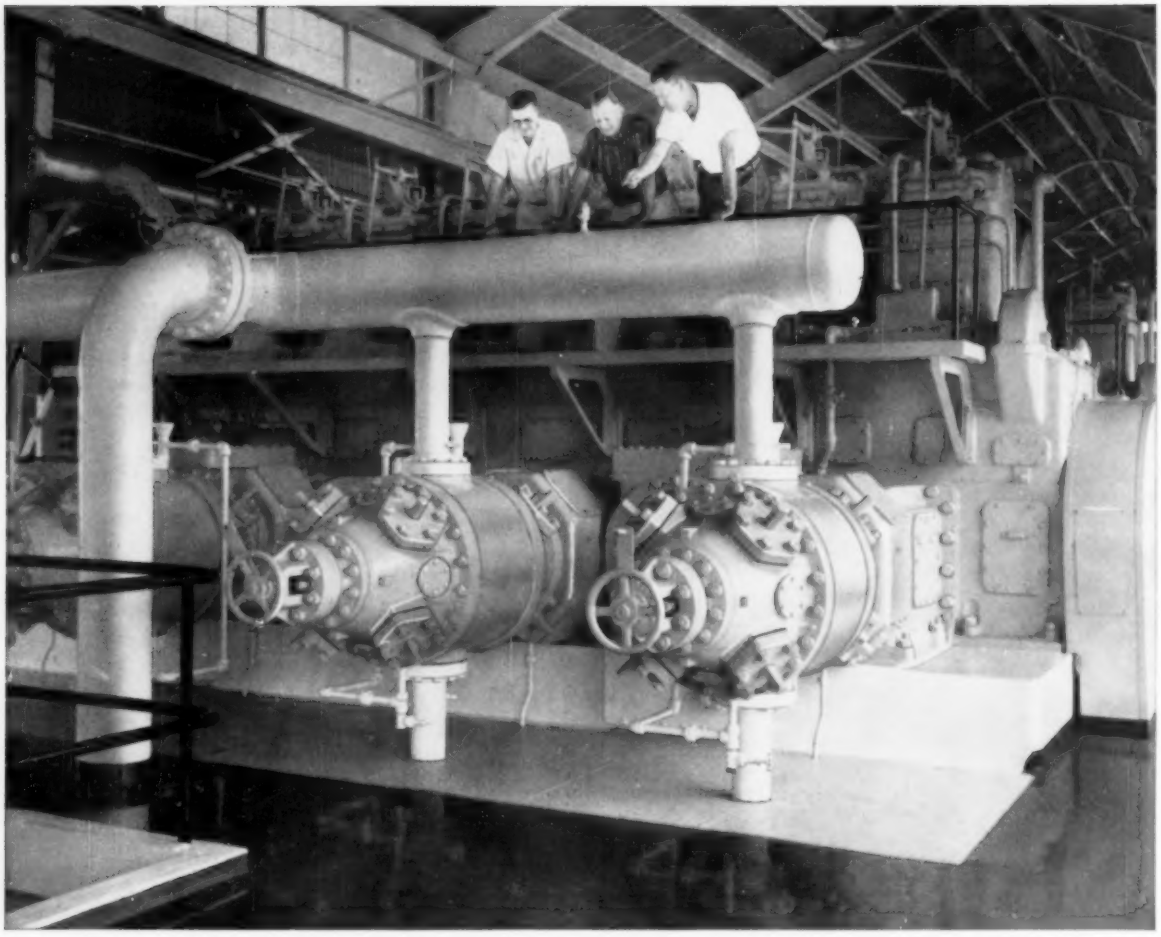
Let us show you how economically Beaird-Ingersoll-Rand packaged compressor plants can be added to your compressor station.

BEAIRD
another AMF product
PACKAGED COMPRESSOR PLANTS

LOWEST COST PER HORSEPOWER INSTALLED

THE J. B. BEAIRD COMPANY, INC.
Shreveport, Louisiana
A subsidiary of American Machine & Foundry Company

SHREVEPORT, LOUISIANA • *Sales Offices: Dallas, Houston, Corpus Christi and Midland, Texas • New Orleans, Louisiana • Tulsa, Oklahoma • Denver, Colorado Los Angeles, California • Caracas, Venezuela, and Cie. Ingersoll-Rand, Paris, France.*



Richard N. Rogers, Results Engineer (left), W. C. Drienhofer, Station Superintendent, and R. A. Cuyler, Jr., Gulf Sales Engineer, inspect one of the 31 units lubricated by Gulf Security since 1944.

At Tennessee Gas Transmission Company's Middleton Station . . .

Not a ring change in 26,800 hours with

GULF SECURITY OIL

31 gas engine compressor units have been running smoothly at the Middleton Station with Gulf Security Oil since 1944. The records show 26,800 hours operation without a single ring change. And after 85,000 hours, Security in the crankcase was still in excellent condition.

Here for 13 years Gulf Security has lived up to its name—security against operating troubles and high maintenance costs. Gas engine compressor units lubricated with Gulf Security are consistently free of heavy port and ring belt deposits. Wear is negligible—in fact, ring and liner life in both power and compressor cylinders is well above average. Bearings last longer, too.

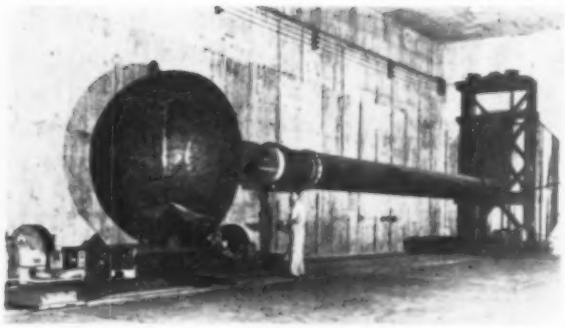
When you use a Gulf product you get an extra dividend—the free services of an experienced Gulf engineer. He's always "on call" to assist you with any problem involving lubricants, fuels, or any other petroleum product. Write, wire or phone your nearest Gulf office.

GULF

GULF OIL CORPORATION

1822 Gulf Building
Pittsburgh 30, Pa.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



Show Hits the Road

The Harnischfeger Corporation Construction & Mining Division dealer's sales and service traveling show is shown with Messrs. Ploetz, Catalane and Parthum, company traffic manager, general sales manager and sales promotion manager, respectively, at the start of its eighteen city itinerary. The show is expected to return to the Milwaukee, Wisconsin, plant next July by which time it will have traveled over four thousand miles visiting twenty-two eastern and mid-western states.

Each stop is scheduled to place the show in a P&H dealer's showroom on a Friday morning. Both sales and service representatives of Harnischfeger then spend the day briefing the dealer organization on the company's current sales program, business outlook, as well as stressing up-to-date service methods. On the following day, a Saturday, the dealer holds an open house to which all of his customers and prospects are invited to look over the displays, he brought up to date with new Harnischfeger developments and discuss their problems with dealer and P&H personnel.

Houdry Forms New Contract Research Group

Houdry Process Corporation has announced the formation of a special Contract Research Group at the company's research and development laboratories. Houdry manufactures catalysts and chemicals, and licenses catalytic processes used in petroleum refining and chemicals processing industries. With formation of the new group, research and development programs will be undertaken either on a single project or a long-range basis, for licensees and non-licensee companies, in other industries in addition to refining and chemical processing.

The new Houdry research service will interest companies concerned with solid state chemistry, such as manufacturers of transistors, diodes and miniature ferroelectronic devices; fine chemical producers, heavy chemical plants having special problems in hydrogen treating and catalysis; and plastics and rubber processors and manufacturers. The group was formed because of special need for contract research and development services founded on solid industrial experience in the scientific aspects of research, and the practical aspects of sound commercial development of promising projects.

Houdry's new Contract Research Group will function directly under George F. Hornaday, associate manager of research and development at the Houdry Laboratories. T. H. Milliken, former section chief in catalyst research and development will head the group.

Fuller Opens West Coast Plant

A new $1½ million plant in Compton, California, has been opened by Fuller Company, a subsidiary of General American Transportation Corporation. The company manufactures pneumatic handling equipment and supplies rotary compressors, vacuum pumps, preheaters and clinker coolers. Light metal fabrication facilities for manufacturing Fuller equipment are in operation at the new plant.

Baroid Adds Space

Baroid Division, National Lead Company, has occupied a new building addition, which subjoins its present general office building in Houston, Texas. New construction will provide about 15,700 sq ft of space. Six new laboratories are included and, with space being freed for four other labs in the present building, Baroid's laboratory space will be increased 43.5 percent.

Frenchmen Visit M. J. Crose

Two representatives from the largest pipeline construction company in Europe visited the M. J. Crose Manufacturing Company, Inc. plant in Tulsa, Oklahoma.

Left to right are Paul Evans, Crose Sales Engineer, discussing coating and wrapping with G. Chambrier, company spread man, and E. J. Perrussot, public relations man, both with the pipeline department of the Societe Parisienne pour l'Industrie Electrique, Paris, France. The Frenchmen were in the United States several weeks attending the School of Pipeline Technology, an API-University of Texas sponsored center at Baytown, Texas. They visited the Crose plant to inspect the manufacture of machines widely used in their European and African pipeline construction projects.

X-Ray Equipment Installed

Chicago Bridge & Iron Company's 1,000,000 X-ray machine, one of the most advanced applications to date of super-voltage equipment for industrial radiography, is ready to inspect a pressure vessel head fabricated by the company. CB&I also uses the equipment for non-destructive inspection of welded shell seams in heavy wall pressure vessels. Mounted on rails, the instrument is fixed on the end of a 43-ft long counterweighted boom. An extra-thick concrete structure houses the installation.

Geophysical Organization Offers World-Wide Service

A new organization has been formed by three geophysical companies to provide world-wide geophysical exploration services. Known as NAMCO International, the organization represents the combined facilities and services of National Geophysical Company, Inc., Dallas, Texas, E. V. McCollum & Company, Tulsa, Oklahoma, and Continental Geophysical Company, Fort Worth, Texas. Each of the concerns involved will continue to operate as an independent company in the handling of domestic and Canadian geophysical work but will pool resources for international activities.

Headquarters for NAMCO International will be maintained at 8800 Lemmon Avenue, P. O. Box 13127, Dallas, Texas.

Layne & Bowler Celebrates 75th Anniversary

This year Layne & Bowler, Inc. is celebrating its seventy-fifth anniversary. The firm, headed by W. H. Reeves, was founded in 1882 by Hahlon Layne. Since 1913 it has offered an overall service covering the entire ground water development job, from the initial survey for water to the finished well and pump installation. Layne facilities have been located at strategic points all over the world. The company's research division is the only one devoted solely to the problems of ground water supply development.

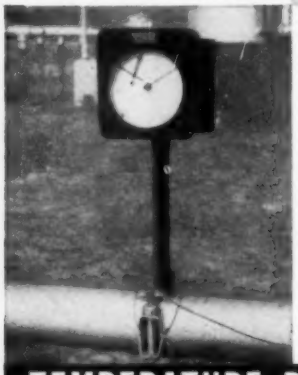
United Supply Opens Store

United Supply and Manufacturing Company of Tulsa, Oklahoma, has recently broadened its services to the Louisiana Gulf Coast with a new store at Grand Isle, Louisiana. This is the twenty-second in the company's group of field servicing and supply points. O. L. Short has been named manager of the store, which has been fully stocked with equipment and supplies to service offshore and inland barge drilling—producing operations.

AUTO-LITE

...for TEMPERATURE RECORDING...

One of the many uses for Auto-Lite Recorders is the application shown below . . . a natural gas field meter run.



Auto-Lite Model "1000" Temperature Recorder has 6" chart. Various standard ranges from minus 40° F to plus 550° F. Available for wall mounting, portable or portable self contained use. Electric or mechanical chart drive. Choice of 24-hr. or 7-day cycle. Capillary tubing permits remote reading. Priced as low as $49.50. Manufactured to customers' specifications. Send for latest Catalog describing many types of Auto-Lite Recorders and Indicators.

THE ELECTRIC AUTO-LITE COMPANY
INSTRUMENT AND GAUGE DIVISION
TOLEDO 1, OHIO
NEW YORK • CHICAGO • SARNIA, ONTARIO

TEMPERATURE RECORDERS & INDICATORS

CORROSION RESISTANT LINE
GLARE FREE MARKINGS
TOUGH LEATHER CASE

EASY TO READ MARKINGS THAT ARE DURABLE

LUFKIN

ANCHOR
Chrome Clad
STEEL TAPE

Bold black markings contrast with exclusive "glare-free" Chrome Clad surface on Lufkin "ANCHOR" Steel Tapes. Multiple coats of electroplate add strength and protection. Wipes clean and is tarnish-proof. Handsome, genuine leather case, hand stitched, with rust-resisting metal liner. Replaceable lines in 25 to 100 foot lengths.

BETTER MEASURE WITH LUFKIN

BUY LUFKIN TAPES • RULES • PRECISION TOOLS FROM YOUR SUPPLY HOUSE

THE LUFKIN RULE COMPANY • Saginaw, Mich.
New York City • Barrie, Ontario

391

NEWS NOTES

THE CLIMAX OF 50 YEARS OF motor truck production is being marked by International Harvester Company with the introduction of a distinctive new "Anniversary Line" of International trucks that ranges from a half-ton A-100 series at 4,200 lb gross vehicle weight to the heavy-duty cab-forward six-wheel ACF-180 series at 33,000 pounds GVW.

TOM EAKIN OIL TOOL SERVICE OF Willows, California, has acquired the Northern California distributorship for Grant Oil Tool Company and Mac-Clatchie Manufacturing Company oil-field drilling and production equipment.

CONSOLIDATED ELECTRODYNAM-ics Corporation has broken ground in Monrovia, California, for two 57,500 sq ft office, laboratory, and plant buildings to house its Transducer and Systems divisions. The $1.5 million development is expected to be completed October 1.

ROCKWELL MANUFACTURING Company acquired the assets of Republic Flow Meters Company of Chicago, Illinois. Republic manufactures electronic and pneumatic instruments and process control equipment. Present management of Republic will remain unchanged.

LINK-BELT COMPANY WILL BUILD a new $5,000,000 bearing plant in Indianapolis, Indiana, to replace and increase by 50 percent the capacity of its present Dodge bearing plant.

THE COLORADO FUEL AND IRON Corporation has completed a new open hearth furnace at its Pueblo, Colorado, steel plant. It has a capacity of 230 tons per heat.

FISHER SCIENTIFIC HAS PUR-chased the laboratory apparatus and supply business of E. Machlett & Son. Fisher will continue the 60-year-old firm as a division. Frank Donics becomes general manager of the Machlett Division.

HEADQUARTERS OFFICES OF ACF Industries, Incorporated, have moved to 750 Third Avenue, New York City. New space also houses the home offices of American Car and Foundry, and Shippers' Car Line, two of ACF's product divisions.

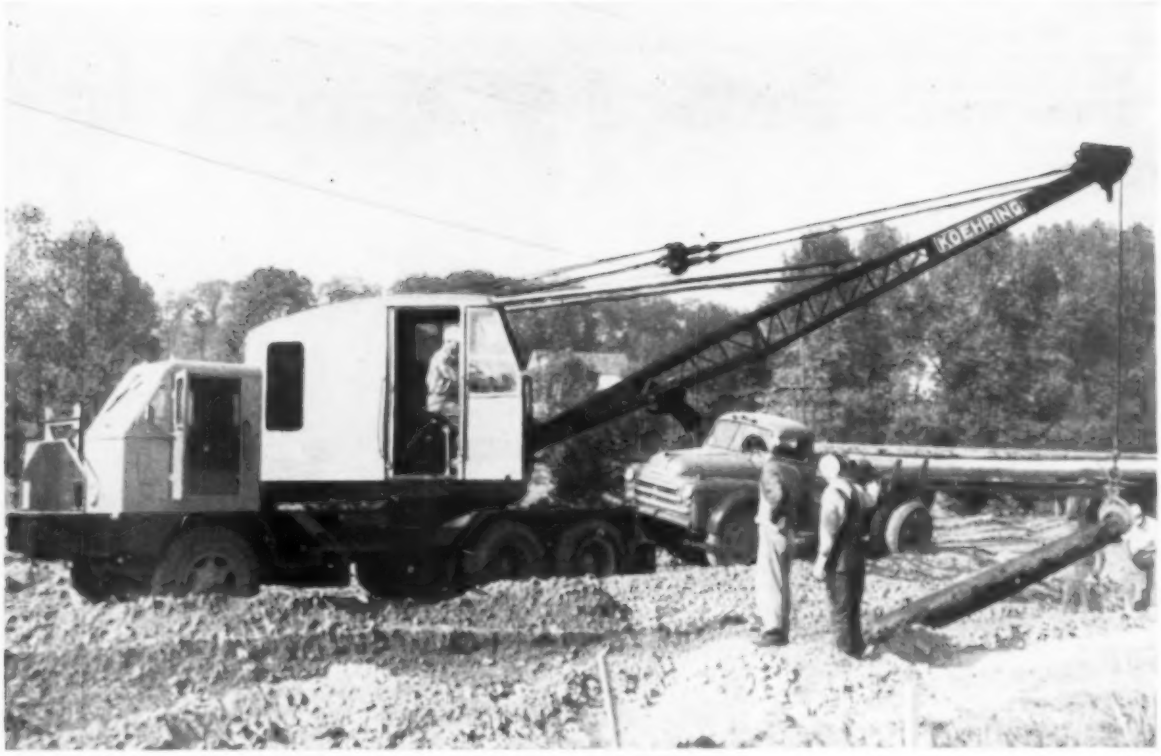
THE McCULLOUGH TOOL COM-pany has opened a service branch at Citronelle, Alabama. W. O. Cole, senior operating engineer, is in charge of this branch.

A NEW "ALL-AMERICAN LINEUP" of low-cost, lightweight, diesel engines has been added to its distribution list by Waukesha Sales and Service, Inc., Houston, Texas.

W. H. & L. D. BETZ HAS CHANGED from the partnership form to the corporate form. Company name has been changed to Betz Laboratories, Inc.

WAUKESHA SALES AND SERVICE, Inc., Houston, Texas, has been named distributor for the Flo-Way Pump line. The tubine pump formerly was distributed under the name of Smith-Way. The change in name was made when the F&F Pump Company of Fresno, California, acquired the turbine pump division of the A. O. Smith Corporation.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



On lifting and material-handling work, where distance between jobs is a problem, take advantage of the speed, mobility, and *extra capacity* of Koehring 205 Truck Crane. It travels anywhere a truck will go — can be 30 to 40 miles from here in less than an hour from "now".

With one of these mobile cranes, you're equipped to lift any load up to 15 tons (based on 85% of tipping load). For high lifts, 25-foot boom can be lengthened to 70 feet. For extra reach, 15 to 30-ft. jib can be added to 65-foot boom. Stability of truck mounting increases the 205's work capacity with every attachment. It handles ½ to ¾-yard clamshell or dragline buckets on a wide work-radius — and quickly converts to ½-yard shovel or hoe.

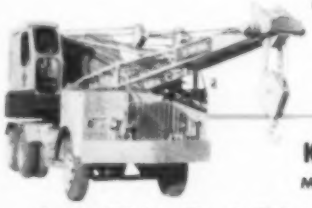
This heavy-duty 205 also is available as a 15-ton Cruiser® crane, or 10-ton crawler crane — with all standard attachments. On rubber-tired Cruiser mounting, it brings you travel speeds up to 21½ m.p.h. — plus one-man operation for both work and travel.

Next time you're in the market for a crane or excavator, look into this 205. Your Koehring distributor has complete facts and figures that will interest you. Why not call him today? Or, use coupon to get complete information by mail.

You get 15-TON LIFT CAPACITY

45 1/2 mph mobility

with this 205 Truck Crane



KOEHRING DIVISION
Milwaukee 16, Wisconsin

Send us 205 data: ☐ truck ☐ Cruiser ☐ crawler model

NAME_____

TITLE_____

COMPANY_____

DIVISION_____

STREET_____

CITY, STATE_____

K65AREV.2 PE

KOEHRING DIVISION of Koehring Company

PEOPLE

Albert R. Kaspark has been appointed manager of technical sales for Wolverine Tube, Division of Calumet & Hecla, Inc.

Loy F. Seamster has been appointed district representative in charge of Twin Disc Clutch Company's Tulsa, Oklahoma, branch office, and **H. B. Hougan** has been appointed district service representative. **Lee Hansen** has been promoted to district representative at the Dallas, Texas, branch office.

Harry G. Smith, formerly executive vice president of the Ohio Injector Company, has been named manager of the newly formed Meter and Service Station Pump Division of A. O. Smith Corporation's Pacific Coast works.

H. G. Smith

M. E. Swaim

M. E. Swaim has been elected vice president — sales, a newly-created position in the National Supply Company.

E. C. Bedker has rejoined Southern Engine and Pump Co. and will represent the company in sales to the drilling and production divisions of the oil industry.

P. N. Engel has been elected chairman of the board of Infilco Inc. **J. S. Gustafson** has been elected president.

P. N. Engel

J. S. Gustafson

Foster E. Backus has been appointed Mid-West regional sales manager for Darling Valve & Manufacturing Company and **Robert C. Gaynor** is new sales engineer.

Walther H. Feldmann has been elected president of the Worthington Corporation. He succeeds **Edwin J. Schwanhausser,** who became vice chairman of the board.

W. H. Feldmann

E. J. Schwannausser

Percy Tinsley has been appointed special offshore representative for Christensen Diamond Products Company.

Percy Tinsley

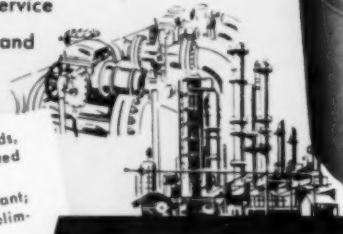
W. A. Hebeler

Walter A. Hebeler has been appointed director of export sales, tractor group, Allis-Chalmers Manufacturing Co.

Member: Esquire, Diners Club, Signet, Trip Charge, Approved AAA, Duncan Hines.

Pipelines and Refineries....
DEPEND ON *Line Scale*
VALVES and SEATS!

For all reciprocating pumps, regardless of size, age, or model . . . in Bronze and Stainless Steel to meet every need, providing long service at pressures up to 1,500 P. S. I. and temperatures up to 300° F. Special sizes on request.



- **Nylon Plate**—Insures long life in all fluids, except Phenol, Formic Acid or Concentrated Mineral Acids.
- **Cone Type Spring**—Fully corrosion resistant; cone construction lengthens life of spring, eliminates coil wear.
- **Double Seating Area**—Seating on shoulder and outer rim provides greater seating area and less deformation area.
- **Reversible Valve Plate**—Offers a bonus of double valve life.
- **Quick Change**—Keeper and retainer design provides quick change of spring or valve without use of any tools.

NEW 1957 CATALOG AVAILABLE! Send for YOUR Copy . . . TODAY!

SEE YOUR SUPPLY DEALER

Line Scale COMPANY, INC.

2734 S. High Street
Oklahoma City,
Oklahoma

NOW!

J&L Buttress-Thread Casing

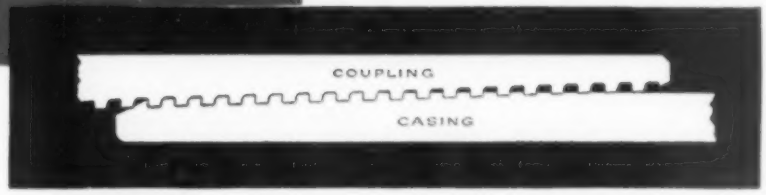
has high strength joint for toughest deep well drilling

High joint strength of J&L Buttress-Thread casing is attained by combined effect of completely engaged runout threads and the three-degree flank angle of the thread. Joint strength is almost equal to that of the body of the pipe.

Easy stabbing, rapid spinning and fewer power strokes to pull the coupling up to the power-tight position are provided by the unique thread design.

A superior casing is assured through use of quality steel, automatically controlled heat treatment, and new precision methods of machining, inspection and testing. Buttress-Thread casing is available in A. P. I. grades J-55, N-80 and P-110 as well as in still higher grades to meet special requirements.

Order this new J&L casing for use in your most severe and variable drilling operations. Write for complete information to the Jones & Laughlin Steel Corporation. Dept. 418, 3 Gateway Center, Pittsburgh 30, Pennsylvania.



Coupling threads (five per inch) engage casing threads throughout the entire length of a long coupling. The ¾ inch taper per foot is continuous and without the conventional fast angle vanishing threads. Full section of the casing is utilized in supporting weight of the string. Inside clearance of joint is not reduced by inside upsets.

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KELLOGG SWITCHBOARD AND SUPPLY CO.
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QUALITY COMMUNICATIONS SYSTEMS

Harry H. Brown, inventory manager of Jones & Laughlin Supply Division, has retired after more than 36 years of service. **George A. Sears,** assistant manager of inventory, has been appointed successor to Brown. **Louis D. Wright** has been transferred to Tulsa to assume the duties of assistant manager.

Edward J. Donahoe, formerly with Chicago Bridge & Iron Company, has joined the public relations staff of Universal Oil Products Company and will be responsible for handling the company's advertising.

E. J. Donahoe

M. Nielsen

M. Nielsen has been elected president of The Babcock & Wilcox Company. He succeeds **Alfred Iddles,** who is retiring.

Carol R. Burton has been appointed manager of the U. S. Steel Oil Well Supply Division store at Alice, Texas.

Ralph M. Buzard, formerly manager of sales for International Harvester Company's motor truck division, has been appointed general manager of that division. **Louis W. Pierson,** formerly assistant manager of sales, will succeed Buzard. **William E. Callahan,** formerly sales manager, eastern region, motor truck division, has been appointed assistant sales manager.

Robert K. LeRouax is now senior engineer in charge of wellhead equipment department, and **John P. Oliver** is senior engineer in charge of valve products department, Cameron Iron Works, Inc.

Vernon Halverson of Plastic Applicators has been appointed superintendent of the company's new Odessa, Texas, location.

Vernon Halverson

F. H. Fellows

Frank H. Fellows has been named manager of Bailey Meter Company's chemical and petroleum sales division.

Donald C. Webster, formerly chief engineer, has been elected vice president of Librascope, Inc., manufacturers of computers and controls.

The appointment of **W. M. Boren** as vice president and general manager of Rolo Manufacturing Company has been announced.

W. A. Carroll Jr. has been appointed general sales manager of the Industrial Silencer Division of Burgess-Manning Co. **R. T. Oliver Jr.** will replace Carroll as New York district manager.

Benny Miller has been appointed division manager of the eastern division of Fluid Packed Pump Company.

Benny Miller

J. E. Warren

The First National City Bank of New York has appointed **J. Ed Warren** a senior vice president. He has directed the bank's petroleum department since joining the organization.

Martin P. Kerins has been appointed sales manager, industrial national accounts, for Stauffer Chemical Company.

Newly elected members to the board of directors of Houston Oil Field Material Company, Inc. are **W. L. Medders,** chief

W. L. Medders

A. J. Adams Jr.

R. M. Freeman

H. T. Hamm

engineer; **A. J. Adams Jr.,** personnel director; **R. M. Freeman,** general sales manager, and **H. T. Hamm,** comptroller.

Gerald L. Dennis has been appointed manager of field sales for the Naugatuck Chemical division, United States Rubber Co.

Gordon N. Dow has been appointed general sales manager of Leschen Wire Rope Division, H. K. Porter Company, Inc.

Billy D. Cass and **James G. Hudnall** have been appointed sales engineer and service engineer, respectively, by the J. B. Beaird Company, Inc.

B. D. Cass

J. G. Hudnall

James G. Huiett has been appointed sales manager of Kenco Pump Division.

LAUGH with BARNEY

Demonstrating once again the importance of the lowly comma, this telegram was sent from a wife to her husband: *"Not getting any, better come home at once."*

* * *

The stranger walked up to a Las Vegas dice table and laid down a $1000 bet. He shook the dice, but as he threw them a third cube fell unexpectedly from his sleeve. The house operator was unruffled. He handed back two of the dice and pocketed the third, saying, "OK, roll again. Your point is 15."

* * *

A sweet young thing of our acquaintance decided that she would rather be a young man's slave than an old man's darling, because she couldn't stand the idea of old age creeping up on her.

* * *

Lets shed a tear for the unfortunate shoe salesman, with a lisp, who got slapped when he asked an adequately proportioned female to sit down while he "looked up her thize."

* * *

In a recent discussion on world affairs, a friend observed the difference between war and peace is there has never been a good war.

* * *

Do you know what a po ho is? A miserable mistress in Mississippi.

* * *

83-year old lady to doctor: "My husband has lost his honeymoon attitude."
Doc: "How old is your husband?"
Old lady: "92."
Doc: "When did you first note he lost his honeymoon attitude?"
Old lady: "Last night and again this morning."

* * *

A much married society darling has gone into deep mourning since the death of her last husband. She even insists on black olives in her martinis.

* * *

Architects cover their mistakes with ivy, doctors with sod, and brides with mayonnaise.

* * *

Prisoner to fellow inmate: "I was making big money — about a quarter of an inch too big."

* * *

Over a roadside auto repair shop hangs this sign: "May we have the next dents?"

* * *

Sign posted on a Scottish golf course: "Members will kindly refrain from picking up lost balls until they have stopped rolling."

* * *

A lonely chick taking a look around the electric incubator of unhatched eggs — "Well, it looks as if I'll be an only child. Mother's blown a fuse."

* * *

In the old days, if anybody missed a stagecoach he was content to wait a day or two for the next one. Now he lets out a squawk if he misses one section of a revolving door.

Two friends who hadn't seen each other in years met on the street. After an embrace they started asking about old acquaintances.

"How's Joe?"

"Poor Joe, he died over a year ago."

"Poor Joe? wasn't he rich?"

"In a way, but he left everything to an orphanage."

"How much?"

"Ten children."

Recently a lady guest marched up to the desk of a well-known Los Angeles hotel. "I thought this was a respectable place," she complained.

"Is something wrong?" the clerk inquired.

"As I was waiting for the elevator I saw a man chasing a nude girl down the hall."

"Did he catch her?"

"No, she made it to her room and slammed the door."

"Madam, this hotel is still respectable."

* * *

Golfer — A guy who can walk several miles toting a hundred pounds or more of equipment, but who has Junior bring him an ash tray.

* * *

If a girl doesn't try to hold her shape, neither will the boys.

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Books to Read

Successful Office Automation, *by Ralph W. Fairbanks, published by Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, New York. Pages, 355. Price $10.*

Today a top or near the top question is how much office automation is economically feasible. This volume gives a practical and comprehensive answer to most questions you want to ask. It describes the steps by which a system is created and illustrates how a good system will give an office the degree of automation appropriate to its size and work load.

Text is lively and easy reading. Format makes it a convenient volume to use with its edge index and chapter summaries.

Good management reference book for most managers, including heads of district operational units of some size.

Testing of Weighing Equipment, *National Bureau of Standards Handbook H37, by Ralph W. Smith, reprint, 184 pages, $1.25. (Order from the Government Printing Office, Washington 25, D. C.)*

This publication which is a standard reference in the field of weights and measures has been reprinted because of public demand. It is one of a series of handbooks designed to present in compact form comprehensive information relative to weights and measures supervision. H37 also describes various types of scales and weights, the principles of their operation, and methods for their inspection and test.

API Specifications for Centrifugal Pumps for General Refinery Services, 2nd Edition, *published by the American Petroleum Institute, Division of Refining, 50 West 50th Street, New York 20, New York, API Standard 610, Pages, 22. Price, $1.50.*

This booklet covers general considerations, design of all maior parts, materials, inspection and testing methods, preparation for shipment, drawings and other data required of and for the manufacturer, and details on proper handling of proposals. Of special aid is an appended standard data sheet for specifying centrifugal pumps.

Classification of Rocks, *by Russell B. Travis. Published by Colorado School of Mines, Golden, Colorado. Price, $1.00.*

A best seller among both the amateur "rock hounds" and the professional geologists, the Colorado School of Mines Quarterly, "Classification of Rocks," is now available in a revised edition.

Originally published early in 1955, the volume has sold out two printings to become the school's most widely distributed professional publication.

Written by Dr. Russell B. Travis when he was assistant professor of geology at Mines, it is designed to prevent confusion that results from the many varied methods of rock nomenclature. Dr. Travis has named rocks on the basis of visible features, using terms and conventions generally accepted at present.

Stress Corrosion Cracking and Embrittlement, *edited by William D. Robertson, published by John Wiley & Sons, Inc. 440 Fourth Avenue, New York 16, New York. Pages, 200. Price, $7.50.*

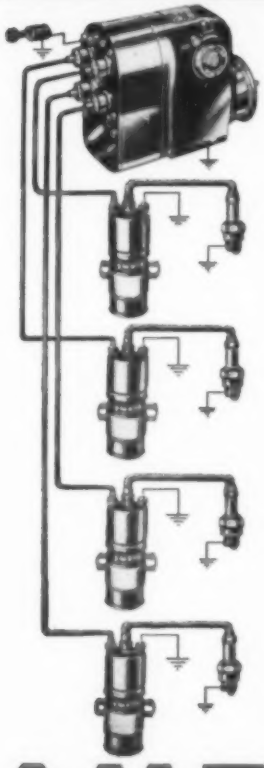
Sixteen outstanding people in the field stress corrosion cracking and embrittlement have contributed to this symposium. Its chapters are devoted to discussion of the phenomena in mechanism of stress corrosion cracking, molecular structure, cracking mechanism in various types of alloys including aluminum, magnesium, stainless steel, mild steel with several chapters covering the effects of hydrogen upon various alloys.

Contributions of J. M. Pearson to Mitigation of Underground Corrosion, *NACE Publication 56-12. Published by National Association of Corrosion Engineers, 1061 M & M Building, Houston 2, Texas.*

Six papers by the late Dr. J. M. Pearson and one by a co-worker have been reprinted in a book form. The 56-page and paper cover book measures 8½ by 11 in.

When Dr. Pearson died in November, 1952, he was director of the Research and Development Department, Physical Research and Development Division, Sun Oil Company, Newton Square, Pennsylvania. His work while employed by the Susquehanna Pipe Line Company brought him recognition as an outstanding engineer in the underground corrosion field. His papers still are considered to be important both to newcomers into the corrosion mitigation field and to longtime practitioners of underground corrosion mitigation procedures.

Permission to reprint the paper was obtained from *The Petroleum Engineer* and the Transactions of The Electrochemical Society, in which they were published originally. The book is dedicated to Dr. Pearson's memory.



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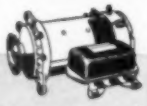
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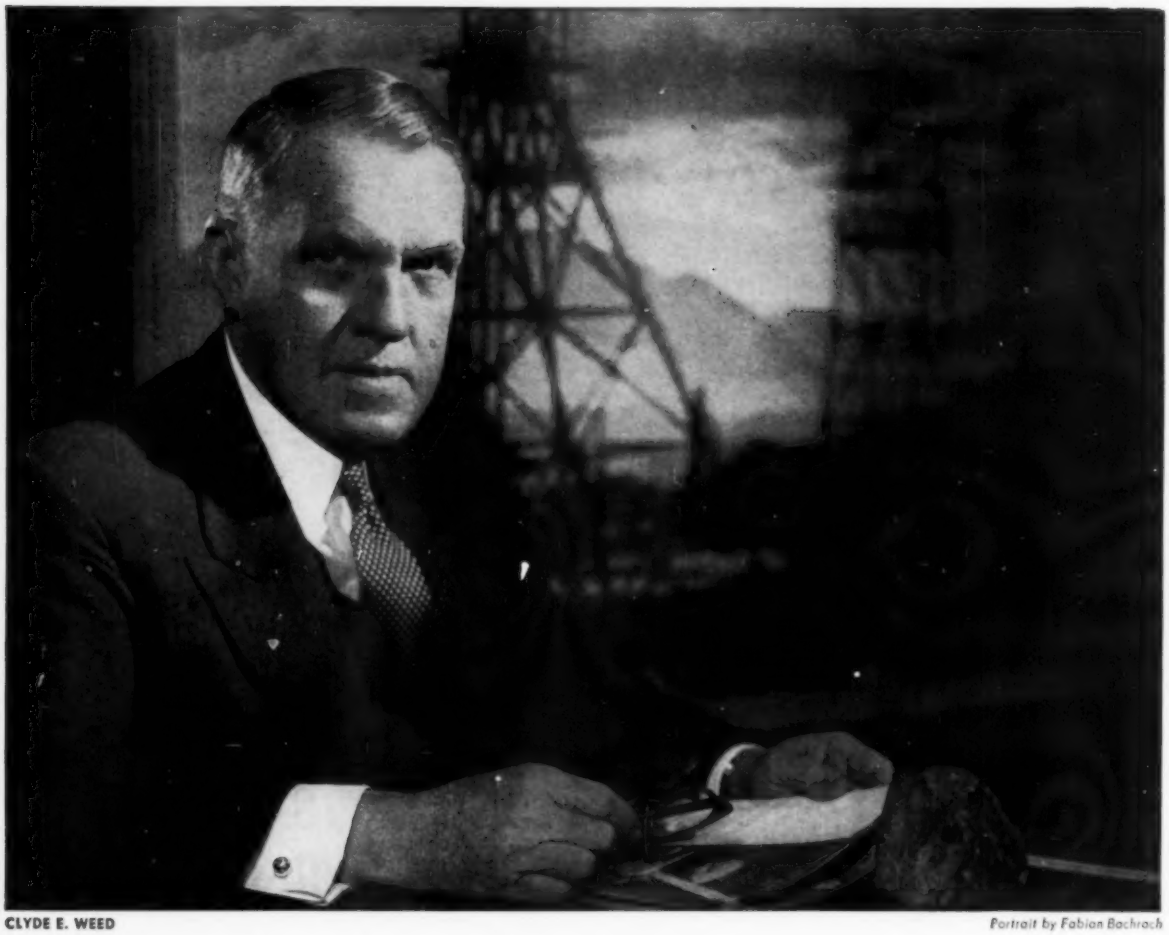
Electric Windshield Wipers

Diesel Fuel Injection Equipment



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CLYDE E. WEED, *President*
The Anaconda Company

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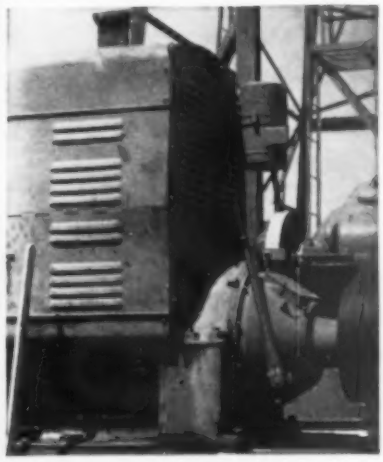

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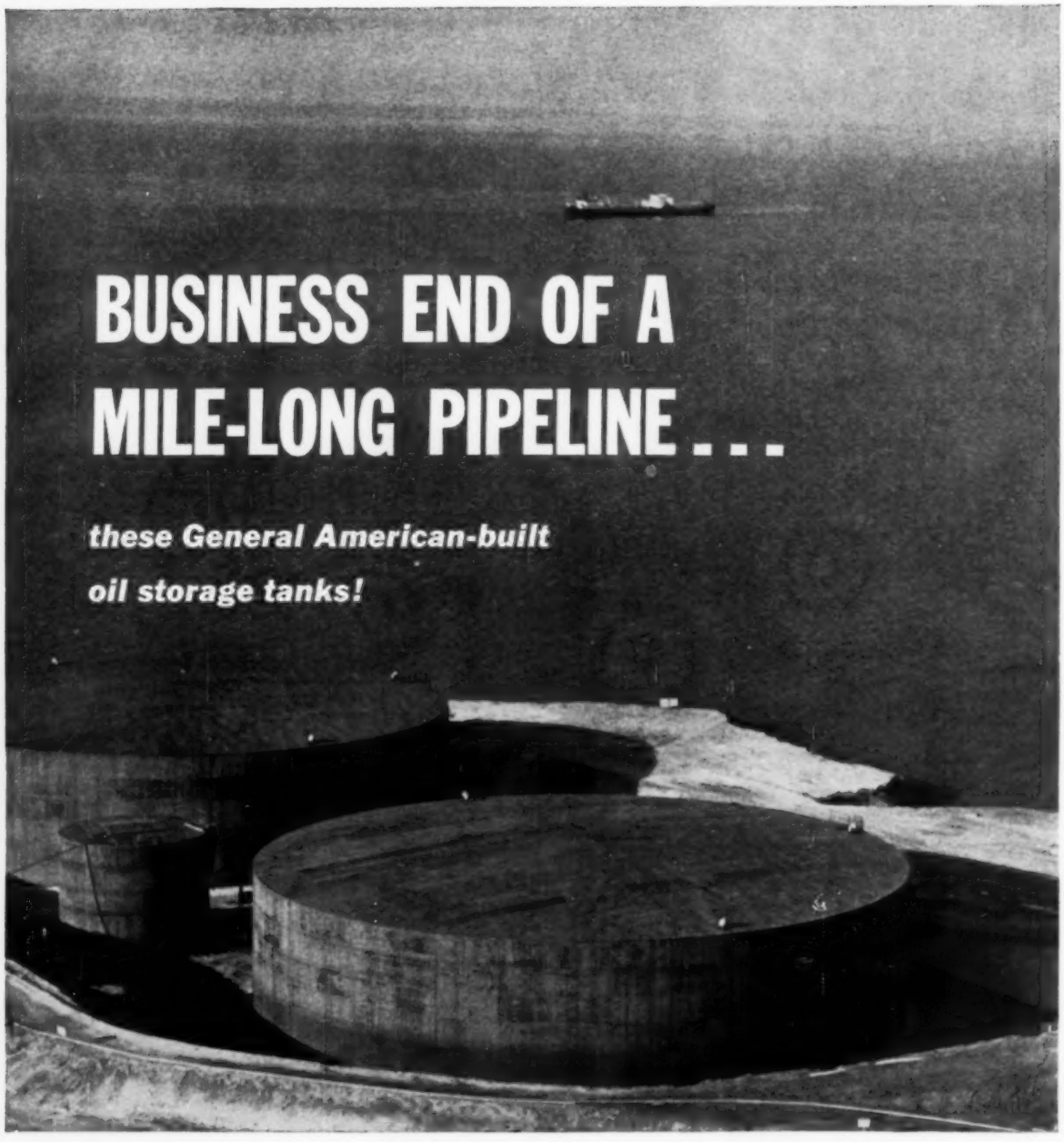

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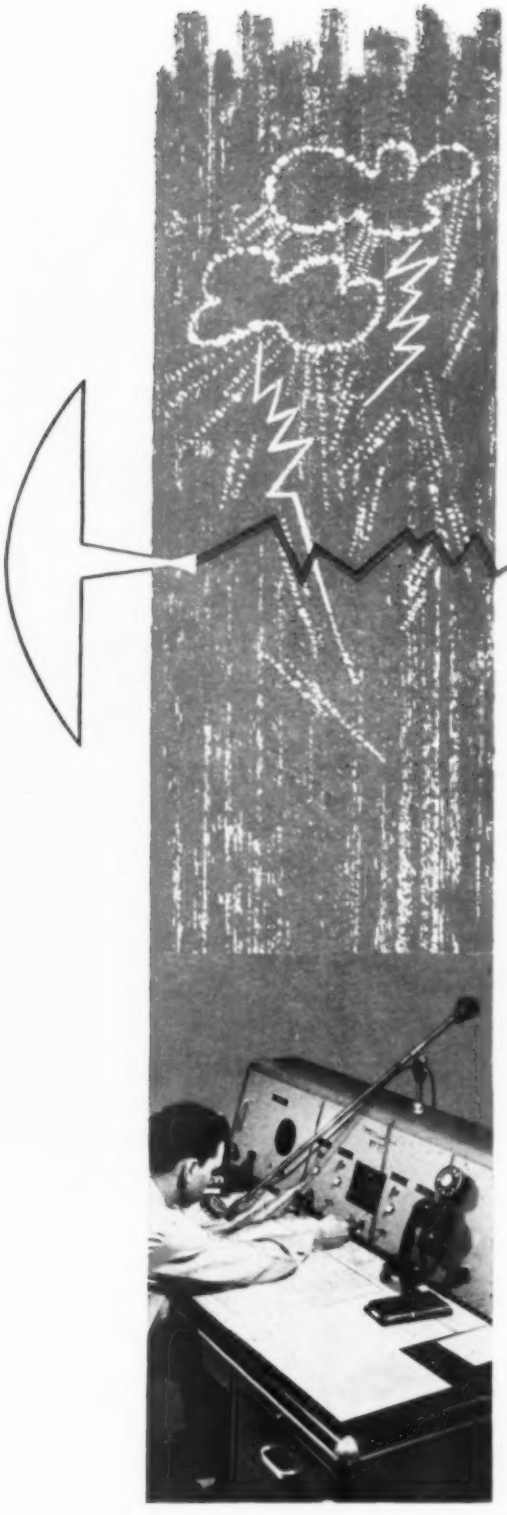

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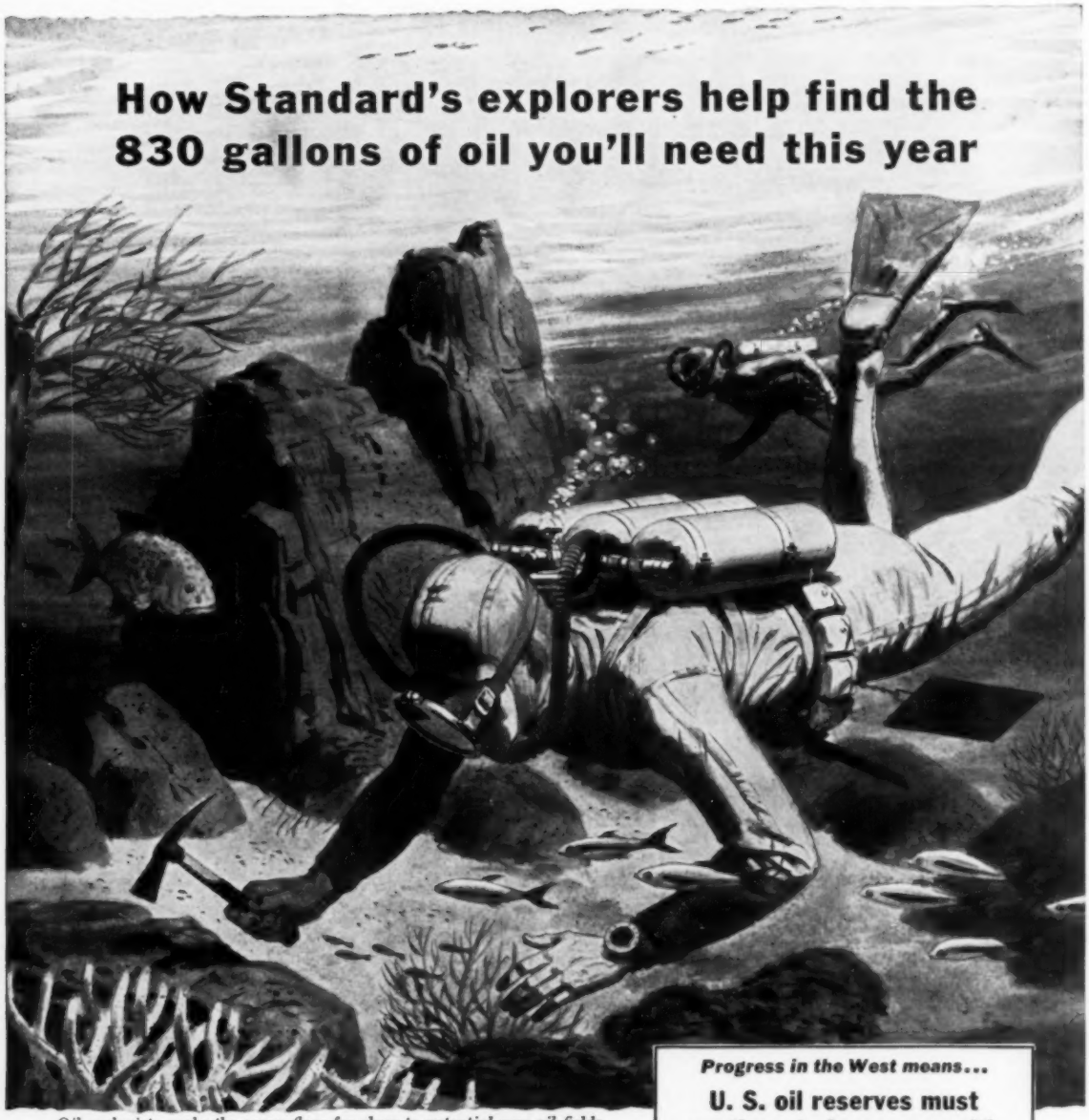

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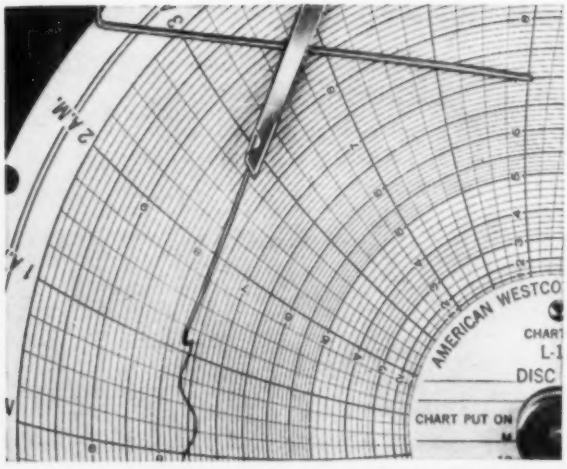

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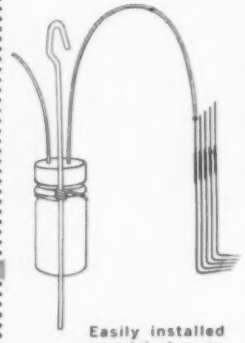
assure legible charts ...eliminate inking problems



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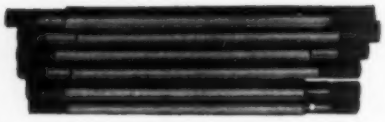
Pump rods hard-faced by ThermoSpray Process give 20 times longer service



New Metco Process hard-faced acid sludge pump rods serve as much as 20 times longer than unfaced rods.

A number of oil companies are making important savings in equipment down-time and replacement part costs with the METCO THERMOSPRAY* Hard-Facing Process. Typical of these parts are pump sleeves, as well as the acid sludge pump piston and rods shown here. Operating conditions were severe—rods had to be replaced every 24 hours—new packing every 8 hours. Hard-faced rods now last over 500 hours; packing more than 60 hours. Coatings are extremely dense and non-porous—homogeneous.

The THERMOSPRAY Hard-Facing Process consists of spraying specially developed alloys in powder form with the METCO THERMOSPRAY GUN. No compressed air is required. Coatings have hardness of Rc 30 to Rc 65, depending on the specific THERMOSPRAY alloy used; will outwear hardened steels from 3 to 10 times. Spraying speeds are higher—8 to 10 lbs. per hour—and deposit efficiency far greater (up to 97%)—than with any other type of available equipment. Hard surface depth can be closely controlled and the smooth surface left after spraying requires a minimum of finishing.

Write today for free descriptive Bulletin 126A or a call by a full-time, company-trained, Metco Field Engineer in your territory. Or see your local metallizing job shop.

The following trade names are the property of Metallizing Engineering Co., Inc.: METCO, ThermoSpray.*
**Reg. U.S. Pat. Off.*

Metallizing Engineering Co., Inc.
1149 Prospect Ave., Westbury, L. I., New York • cable: METCO
In Great Britain: Telephone: EDGEWOOD 4-1300
METALLIZING EQUIPMENT COMPANY, LTD.—Chobham near Woking, England

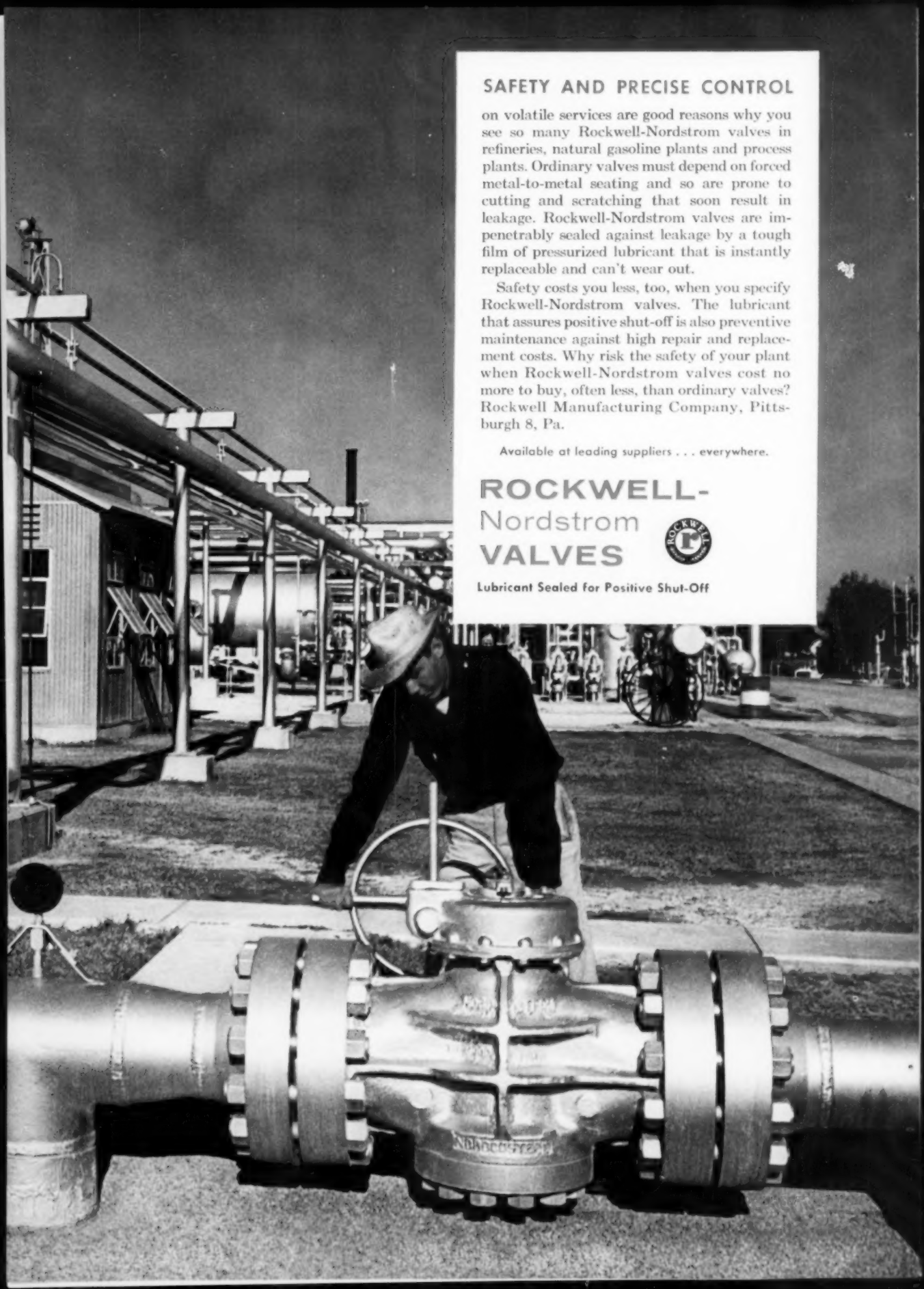
INSTANT, DEPENDABLE RESPONSE to push button or automatic flow control is assured when you specify Rockwell-Nordstrom valves. Their basic advantage for power operation that is lacking in ordinary valves: *lubrication*. Because the plug is seated on a film of pressurized lubricant, a "friction-free" surface keeps the valve ready for instant, smooth operation. And since the lubricant reduces torque and the plug is fully open or closed in a quarter-turn, a simpler, less costly actuator is needed.

Rockwell-Nordstrom valves are available in a complete range of sizes and pressure ratings with electric, pneumatic and cylinder operators. They cost no more to buy—often less—than ordinary valves. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

Available at leading suppliers . . . everywhere.

ROCKWELL-
Nordstrom
VALVES

Lubricant Sealed For Positive Shut-Off



SAFETY AND PRECISE CONTROL

on volatile services are good reasons why you see so many Rockwell-Nordstrom valves in refineries, natural gasoline plants and process plants. Ordinary valves must depend on forced metal-to-metal seating and so are prone to cutting and scratching that soon result in leakage. Rockwell-Nordstrom valves are impenetrably sealed against leakage by a tough film of pressurized lubricant that is instantly replaceable and can't wear out.

Safety costs you less, too, when you specify Rockwell-Nordstrom valves. The lubricant that assures positive shut-off is also preventive maintenance against high repair and replacement costs. Why risk the safety of your plant when Rockwell-Nordstrom valves cost no more to buy, often less, than ordinary valves? Rockwell Manufacturing Company, Pittsburgh 8, Pa.

Available at leading suppliers . . . everywhere.

ROCKWELL-
Nordstrom
VALVES

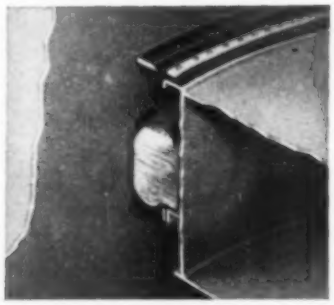
Lubricant Sealed for Positive Shut-Off

every oil operator wants to know

HOW TO PREVENT LIGHTNING FIRES IN TANKS

the answer is now available

USE HAMMOND TUBESEAL* FLOATING ROOFS!

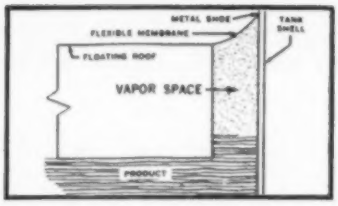


TUBESEALS are made lightning-proof with their exclusive electric conductor weather seal.[1] This specially compounded synthetic rubber, extending continuously around the entire perimeter, between roof and tank shell, provides an infinite number of contact points. ELABORATE TESTING by an independent laboratory[2] discloses that the seal prevents isolation and collection of static electricity charges, providing a continuous conductive surface with large current carrying capacity. Induced charges from lightning are immediately dissipated and fires are prevented. There are no mechanical contacts to cause sparking.

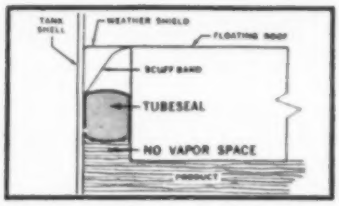
WITHOUT VAPOR THERE CAN BE NO FIRES **. . . the inherent design and construction of Hammond Tubeseals eliminates space between roof, shell, and liquid; thus, there is no room for vapor to form . . . no vapor . . . no fires . . . no evaporation . . . no corrosion!**

Introduced to the oil industry late in 1955, the Hammond Tubeseal found immediate favor with oil companies all over the world . . . there are now more than 200 installations in operation and building. A measure of their conservation values and fireproof features is illustrated by their record of repeat orders from satisfied users—one large oil company, after several test installations, re-ordered more than a score of Tubeseals. The same story of satisfaction exists wherever a Tubeseal is in operation.

Write for bulletin TS



CONVENTIONAL FLOATING ROOF tank has space below flexible membrane where air-vapor mixtures form. Because metal shoe and membrane cannot be absolutely gas tight, vapor is constantly escaping. This condition causes excessive corrosion, may also result in rim fires from lightning or other source.



HAMMOND TUBESEAL FLOATING ROOF entirely eliminates every space where air-vapor mixtures can form. Hammond Tubeseal completely fills space between product surface and roof seal, so that corrosion is stopped (even for sour crudes), and vapor cannot form—hence cannot ignite or be lost.

THE HAMMOND TUBESEAL
for new or old floating roof tanks,

FEATURES

- **lightning and fire proof construction**
- **no moving parts**
- **no mechanical maintenance**
- **climate-proof**
- **non-corrodible**
- **can operate to bottom of tank or above the top**
- **no vapor space below the seal**
- **entire circumference has tight seal under pressure at all times**
- **longer working life expectancy**

*Patented [1]patent pending [2]names on request

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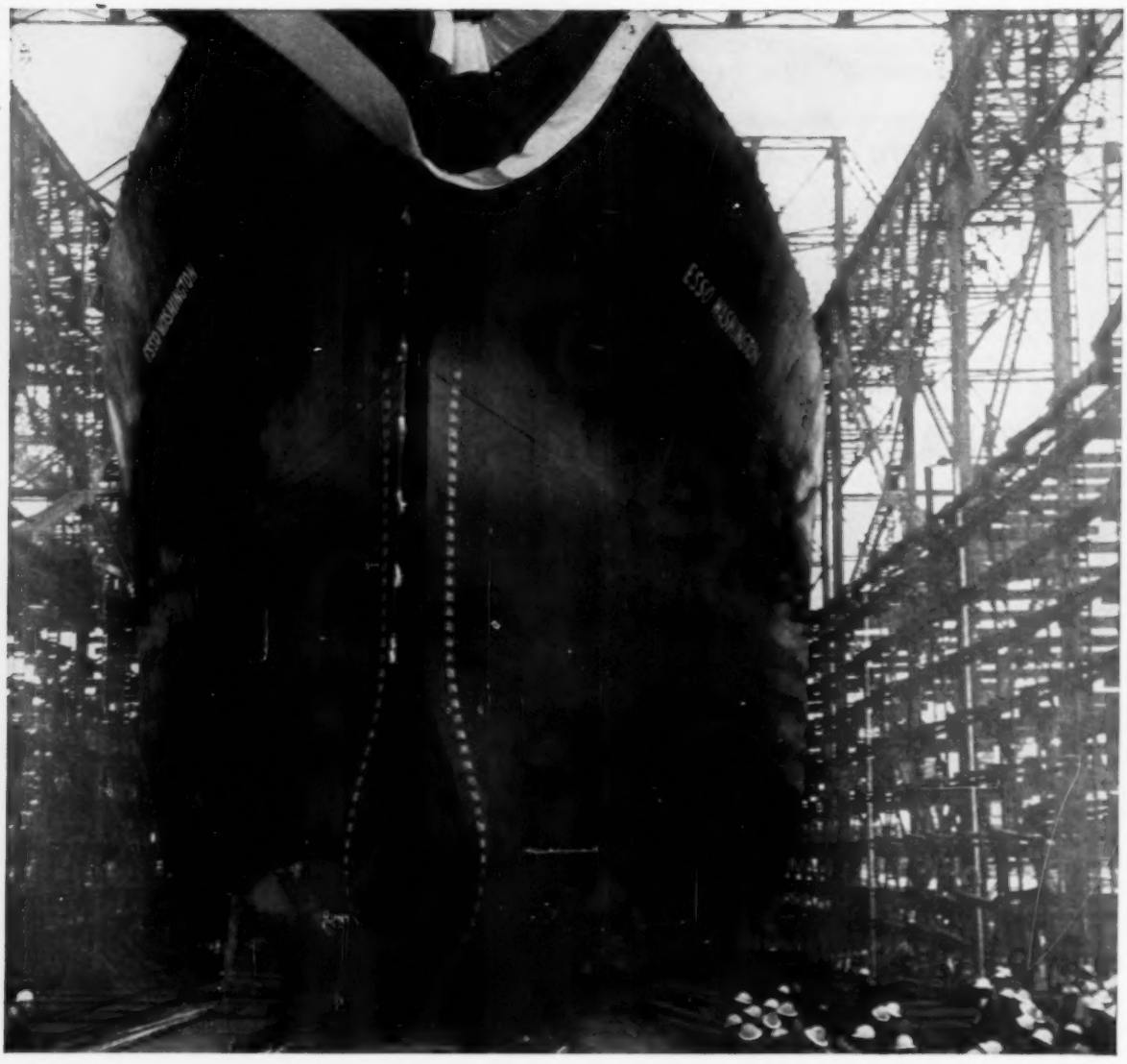

13 MILLION GALLONS BIG...BUT JUST A DROP IN THE BUCKET

The ESSO WASHINGTON is the newest of the 110 ocean-going tankers in the Esso fleets. She can carry 13 million gallons of oil. But that's just a drop in the bucket compared with the 40 billion gallons that Jersey Standard affiliates delivered to customers last year.

As economies expand . . . as populations grow . . . as people live better, oil must provide more energy to power factories, to drive ships and planes and motor vehicles, to heat and light homes and offices. Last year we supplied more than twice the oil we did ten years ago. This year our customers will need still more.

It's a big job . . . and it requires vast amounts of costly equipment. As our Annual Report points out, we spent $1,083,000,000 last year searching for oil and gas and paying for such things as tankers, pipelines and refineries. And in 1957, we plan to spend another $1,250,000,000 to find, produce and deliver the oil people will be needing tomorrow . . . and ten and twenty years from now.

Because Jersey Standard is willing and able to make such investments and because our operations are efficient, we make a profit. In 1956 it was $808,535,000. About half of it went back into the business to help pay for the new facilities.

Our successful year was good news for the 403,000 shareholders who own the company . . . they got dividends of $2.10 per share on the money they invested.

It was good news for our 156,000 employees . . . whose wages and benefits came to $906,000,000.

It was good news for governments. Operating and income taxes, import duties, consumer taxes and other payments from our operations brought to the United States and other governments a record $2,171,000,000. That was five times the dividends to shareholders, more than double the payroll and benefits to employees.

Best of all, our operations were good news for the people of the free world, who rely heavily on the energy of oil for their economic and social progress.

In this, our 75th anniversary year, we intend to continue our efforts to remain successful, profitable and growing, in order to serve people well.

If you would like a copy of our 1956 Annual Report, write us at Room 1626, 30 Rockefeller Plaza, New York 20, N. Y.

Esso 75 YEARS

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AND AFFILIATED COMPANIES

producing energy for an abundant life

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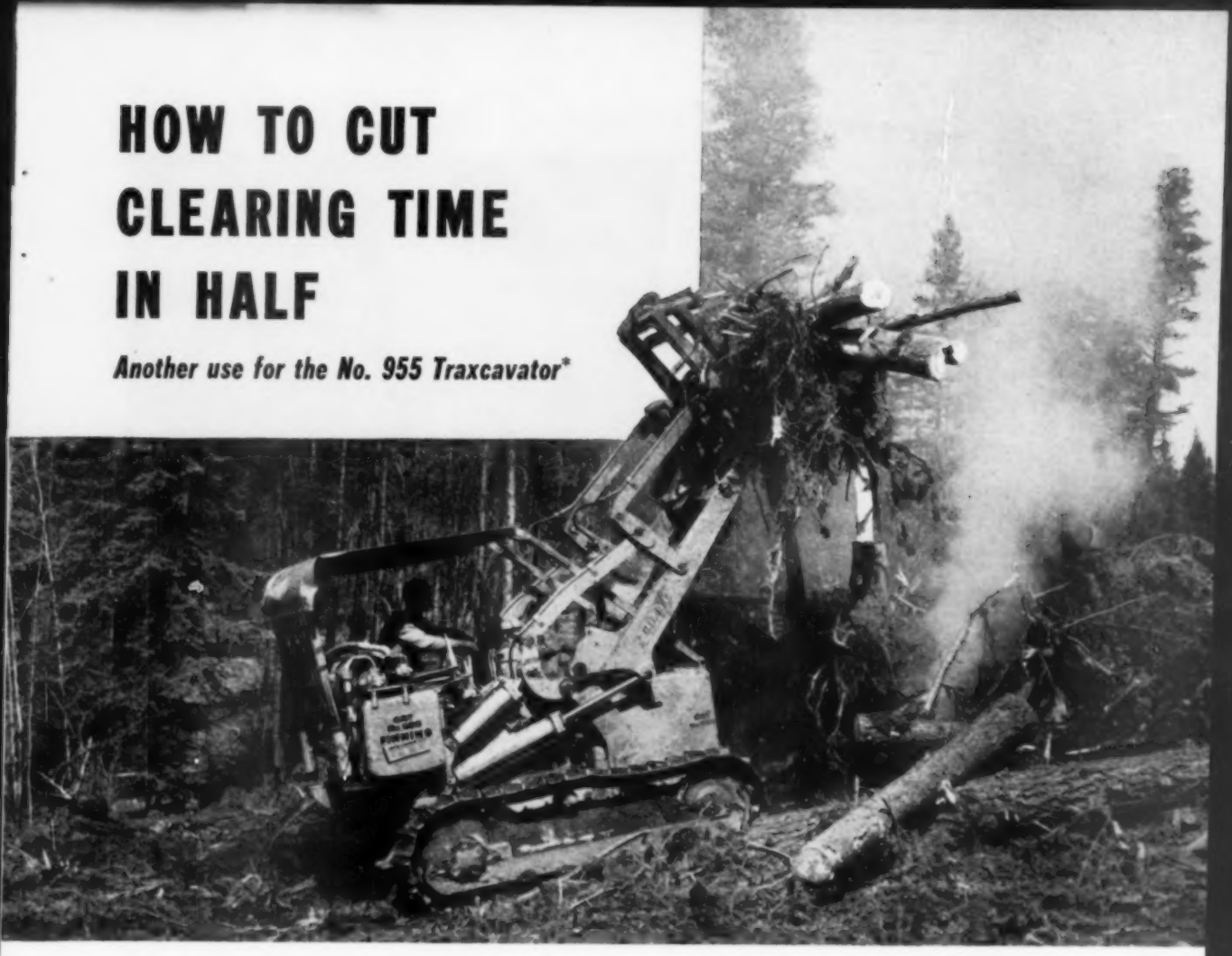
HOW TO CUT CLEARING TIME IN HALF

Another use for the No. 955 Traxcavator*



Conyes Construction Corp., San Pablo, Calif., is using six Caterpillar No. 955 Traxcavators to clear 210 miles of pipeline right-of-way in British Columbia. The company estimates that these Cat-built units *are cutting clearing time in half*. Here's how:

To cut a 60-foot-wide path through jack pine and fir, a D8 knocks down the trees. Everything over eight inches is salvaged by a crew. Then the No. 955s, equipped with alligator jaws operated with a hydraulic ram, pile the logs along the right-of-way and the remaining material on brush fires. The Traxcavators are even used to accelerate the fires. The units lift the top of the pile and use their blower-type engine fans to get a hot fire going quickly.

This method of clearing has enabled Conyes to average one-half to three-quarters of a mile per day in rough going—even working in 10 to 20 inches of snow!

The No. 955 is the newest Caterpillar-built equipment for pipeline spreads. Worked with alligator jaws, general purpose bucket, skeleton rock bucket, or bulldozer blades, this versatile unit enables you to pioneer roads, clear, backfill, build equipment sites and storage yards, and load trucks.

There are three sizes of Caterpillar-built Traxcavators—the No. 933, the No. 955 and the No. 977. They range in size from one-yard to 2¼-yard capacity, and, like all CAT* pipeline equipment, are designed to stay on the job.

Wherever the pipe takes you, you always are near fast, efficient Caterpillar service with factory parts that you can trust. So see your Caterpillar Dealer soon. He'll demonstrate these big, versatile machines on your job . . . at your convenience.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

CATERPILLAR*

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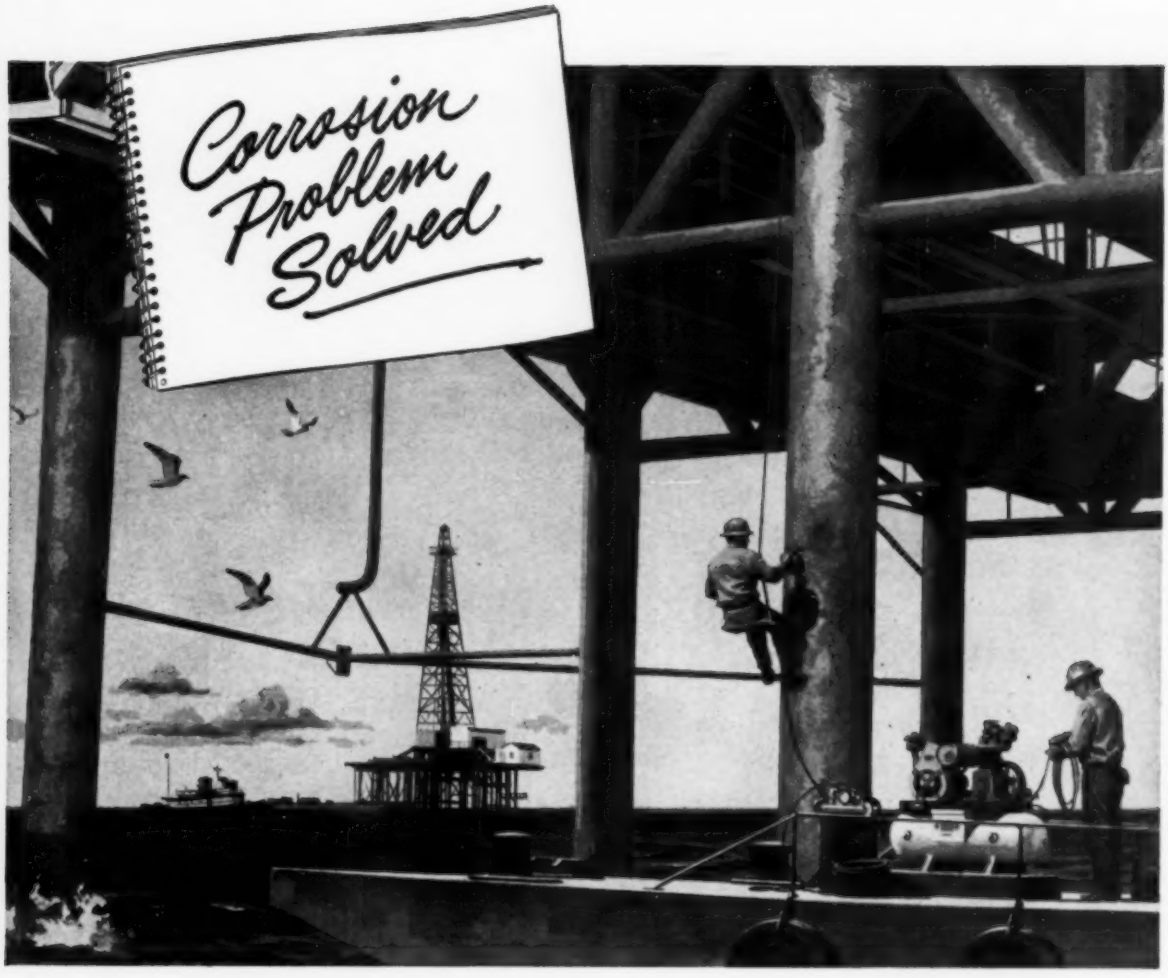
**NAME THE DATE . . .
YOUR DEALER
WILL DEMONSTRATE**



Even offshore, where corrosion is severe, **Humble's coatings** give effective protection!

On costly offshore drilling platforms, Humble's protective coatings have *proved* their ability to resist the powerful corrosive action of salt water splash, spray and vapor. There's a Humble protective coating for every surface from the splash-zone to the crown block, including the working platform and structures on the platform.

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Cut your pumping costs two ways: specify International power on your new equipment; or call in your nearby International Power Unit Distributor or Dealer when it's time to repower. He'll give you a money-saving power recommendation that fits your needs. And you'll find he can be counted on for prompt service and the parts you need when you need them most.

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BRAKESOL is being used all over the world today and is accepted as one of the most effective methods of treating and controlling the paraffin problem.

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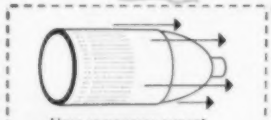
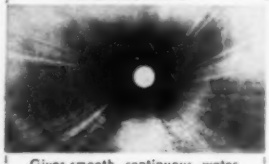


Liner compresses cement mortar onto interior



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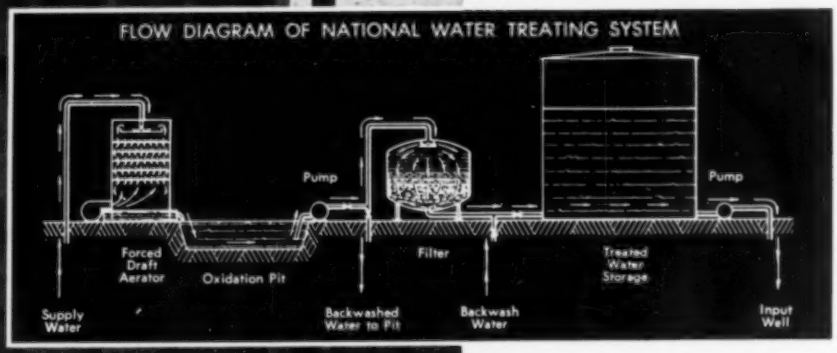
STITT MAKES HEAVY-DUTY, INDUSTRIAL TYPE PLUGS!

AERATION!

National Aerator for treating supply water or disposal water in open water system.



Two National Aerators in series with water supply well located north of Tulsa, Oklahoma.

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Submerged Aerators are also manufactured by National as are complete closed and open water systems.

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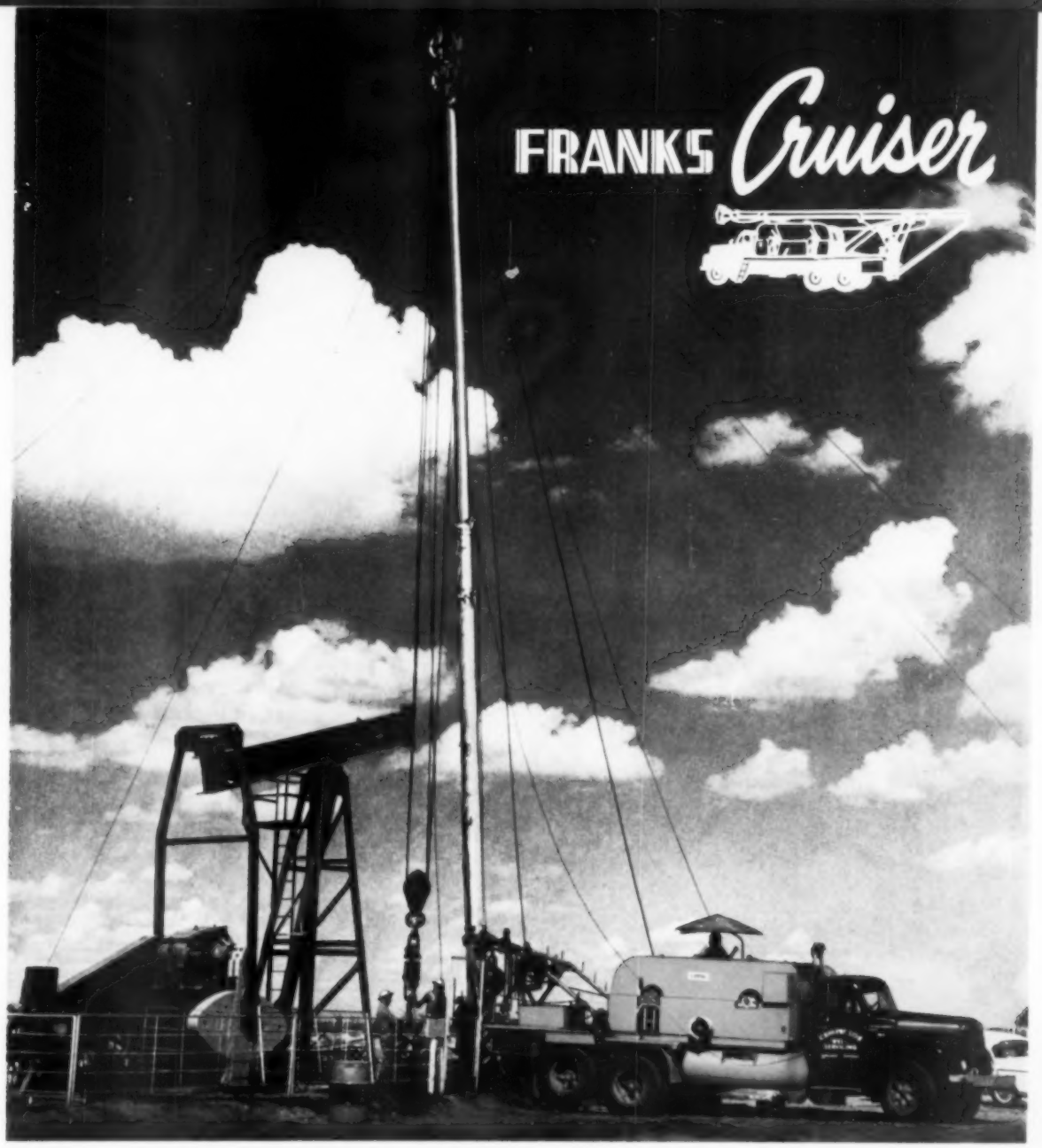

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Just 1¾ inches houses the Lane-Wells' small diameter dual logging instrument — making possible a combined gamma ray and neutron log with a single run in even the smaller holes. The same sharply detailed, consistently reliable curves which have been standard with Lane-Wells well logging service are being obtained with the small diameter instruments . . . and both curves are recorded simultaneously on the same chart for greater savings of time and money. This "best in field" equipment plus the unparalleled experience of Lane-Wells personnel will give you the most useful log possible — call your Lane-Wells man today.

Tomorrow's Tools Today!

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LANE-WELLS CANADIAN CO. IN CANADA
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Of Things To Come . . . In Oil

OFFSHORE ACTIVITY IN LAKE MARACAIBO to pick up due to recently-granted concessions, several of which are "hot" prospects. Kerr-McGee will shortly move new mobile drilling barge to the Lake to commence drilling on a concession in which they have an interest.

OFFSHORE WORKOVERS IN CRITICAL FOCUS. Many older wells are requiring remedial work, pointing up the dark fact that the economic salvation of many offshore wells rests in a drastic reduction in workover costs. Considerable study now underway should bring out some new developments in conventional rigs as well as wire line units.

NEW MICROWAVE SYSTEMS ARE IN THE MAKING for producers. First offshore system was put into service in April by Magnolia. Another major has big plans on drawing board; even Bell Telephone has worked on plans to service offshore operations; others admit it is being discussed. Microwave is believed to hold most of the answers for long-distance production control.

REAPPRAISAL OF OFFSHORE SAFETY PRACTICES is to be expected on heels of series of drilling platform capsizings, other overwater accidents. Oilmen want to put offshore houses in order — before U. S. Coast Guard does it for them. Look for sincere, thorough, industry-wide safety program soon.

RAPID DOMESTIC CRUDE PRODUCTION DECLINE is expected to last until autumn, as demand follows seasonal trend. Decrease has been noted since all-time high in March. Average daily near the end of that month was almost 7,800,000 bbl, peaked by domestic demand and exports to Europe.

"HOT TIPS" ON TOMORROW'S HOT SPOTS have been ventured by API Production Vice President D. L. Connelly. He recently suggested these areas "show signs": Williston Basin in Montana, Delaware Basin of West Texas and New Mexico, Black Mesa Basin in Arizona and Plainview Basin of Texas Panhandle. Today's most active exploratory areas he lists as: Offshore lands of Texas, Louisiana and California, Four Corners area, Oklahoma and Texas Panhandles and deeper horizons in East Texas.

BUCYRUS-ERIE SPUDDERS
speed well fracturing, secondary recovery

BUCYRUS-ERIE spudders are built to handle your well workovers fast and economically. These modern rigs have the speed and mobility to assure rapid progress on hole after hole, with quick easy moves and reduced costs all down the line.

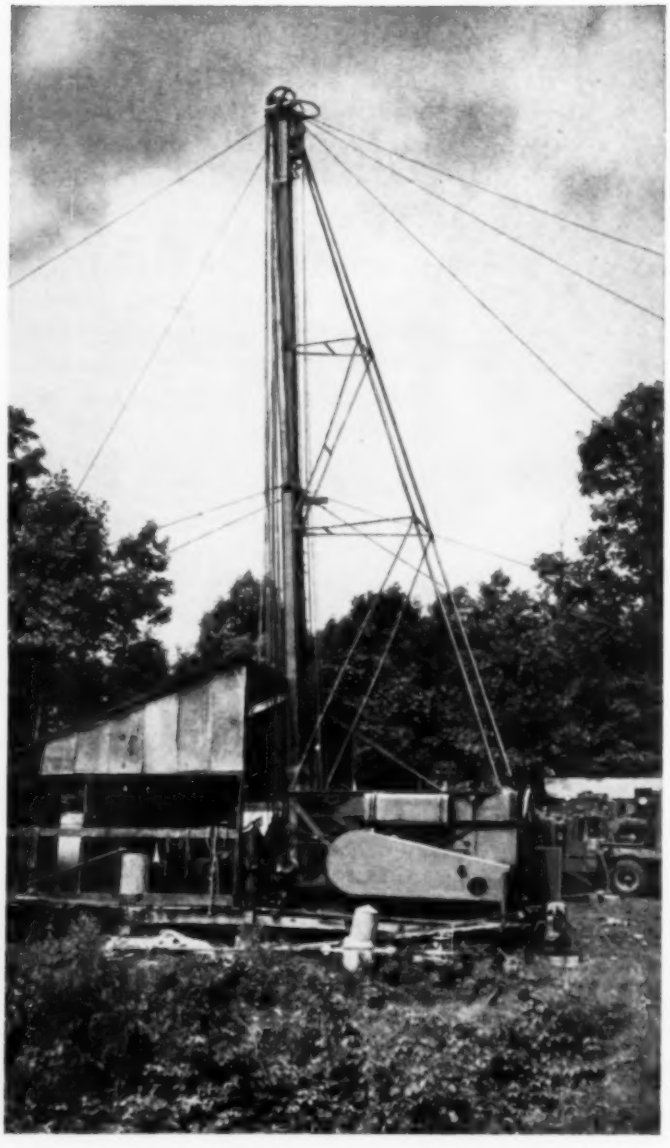
In drilling the injection wells required for a water flood operation, for example, you can't beat the snappy drilling action with which Bucyrus-Eries put down hole. Forward and reverse speeds on all reels and on the catheads provide accurate, split-second control. Reels are free-wheeling for lowering, and fast powerful line pulls ease handling of tools, packers, tubing, swabbing, etc.

In fracturing work, too, these rigs have plenty of speed, strength and capacity for setting casing, handling tubing strings, and running treatment packers.

And when it comes to moves, Bucyrus-Eries save time. Their telescoping derricks are lowered and raised quickly under power; tubular braces unfold smoothly. Mobile semi-trailers or skid mountings make moving easy.

Popular models for this type of servicing work are the 60-L, 28-L and 36-L spudders. Get all the facts from your nearby Bucyrus-Erie distributor or write direct.

42557



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AFFILIATE COMPANIES: CANADA — Perforating Guns of Canada, Ltd.; Edmonton, Alberta
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HERE'S THE BIG ONE...

for the deepest holes ever drilled

Here you have it — the Bethlehem B-3661 drawworks — a drawworks big enough and strong enough for faster, more economical drilling of those deep, deep holes. It's a product representing years of engineering study and development work. The first in its class is now ready for use.

This huge drawworks is capable of drilling to any depths required now or in the foreseeable future. It is by long odds the largest outfit Bethlehem has ever built — largest in shaft size, drum dimensions (36-in. diam x 61½ in. long), brake flanges (64-in. diam), chains, bearings, clutches. Look at the photograph. The man, who is over six ft tall, provides a good comparison.

The B-3661 has all the reserve power ever needed to meet any emergency. It is offered with four speeds for electric-motor application, four speeds and reverse for torque-converters, and six speeds and reverse for conventional mechanical drive. Suitable compounds for three and four engines can be furnished, these being available with two-speed pump-drive transmissions at nominal extra cost.

Three input drive positions are possible, making the unit highly flexible with respect to the positioning of prime movers. In the case of electric-motor drive, two or three motors may be used, each with its own chain to the drawworks.

The B-3661 is making *news*. It is a pioneer in the field of bigger and better drawworks. For full details, call the nearest Bethlehem Supply office. The facts are worth having!

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BETHLEHEM SUPPLY

BETHLEHEM STEEL

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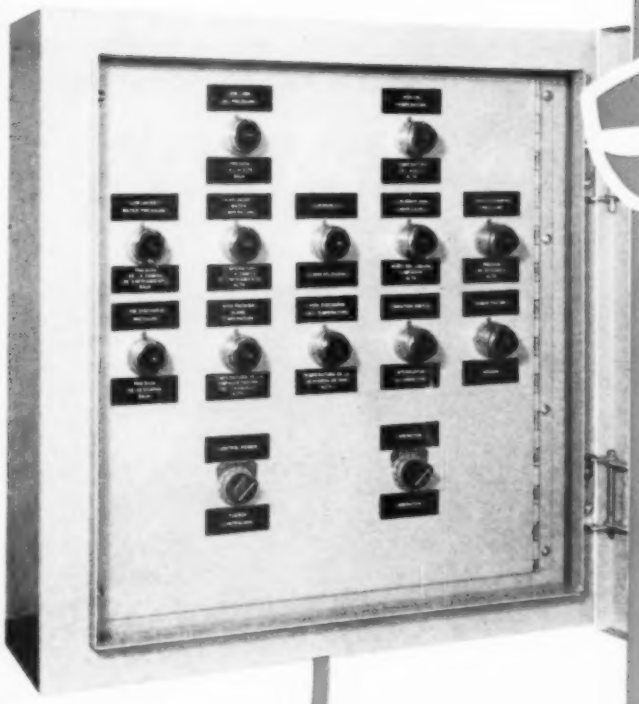
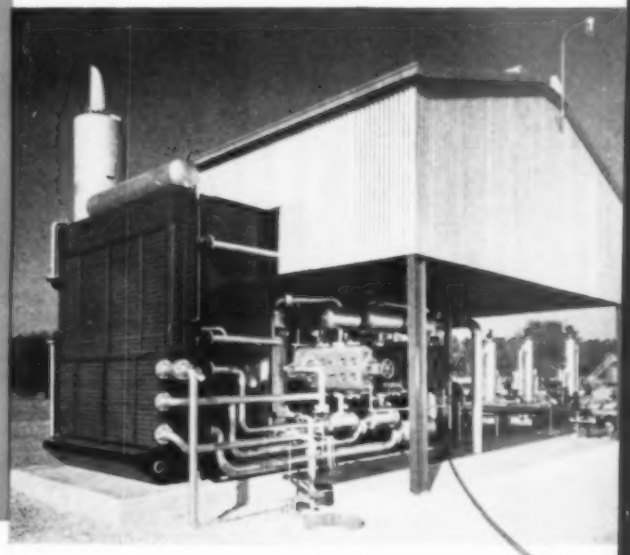
Southwest





NOW THE NEW PANEL CONTROL FOR UNATTENDED COMPRESSOR STATION OPERATION

Southwest Packaged Gas Compressors can now be furnished with automatic shutdown and panelboard indicator equipment custom built to the particular requirements of your station.

Any combination of automatic shutdowns, working through a solenoid controlled valve in the fuel gas system, protects your engine against malfunction.

During normal operation, the signal lights on the panelboard remain off. When any one control switch becomes actuated due to abnormal operation, the signal light corresponding to that switch goes on. The engine shuts down automatically. All other relays are locked out, and the one signal light remaining on indicates the exact switch which caused the engine to shut off.

As many as fifteen separate functions can be pinpointed by this panel indicator. Your maintenance men can get your compressor back on stream faster.

Southwest engineers will give you full details on this protective equipment for unattended compressor operation.

This is another development by Southwest to improve the operation of Packaged Gas Compressors.

FOR GAS LIFT, GAS BOOSTER, PRESSURE MAINTENANCE AND SIMILAR PROJECTS.

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Post Office Box 7773, Houston 7, Texas

Mr. Earl G. Bateman, Owner
Bateman Drilling Co.
New Orleans, La.

Bateman Drilling Reports:

Fuel Averages Less than $70 Per Day with ALCO Diesel-Electric Drilling Power

While proving its reliability in the field, the self-contained ALCO diesel-electric drilling plant is also setting new records in fuel economy. The lower fuel consumption of ALCO diesels has been proved in the field in comparative tests.

Here is what Earl G. Bateman, owner, Bateman Drilling Co., New Orleans, has to say about the ALCO plant on the drilling rig *Henry Bell.* This plant is equipped with two ALCO 900-hp diesels:

"During a period involving 385 actual drilling days, the two ALCO engines consumed an average of 590 gallons per day. At 11.73 cents per gallon, the average daily cost of fuel was $69.23. This fuel cost is considerably lower than that of our other diesel electric drilling rig, equipped with another make plant, which averages about $85 per day."

The ALCO drilling plant is built and backed by the pioneer of diesel-electric power—with over 12 million diesel horsepower in service. Parts for all components of the ALCO diesel-electric plant are stocked in Beaumont, Texas, ready for speedy shipment to any Gulf Coast site. Diesel-electric service engineers are available 24 hours a day.

For more information on the most economical diesel-electric power available, write Transportation Products, Dept. DR-2, P. O. Box 1065, Schenectady, N. Y.

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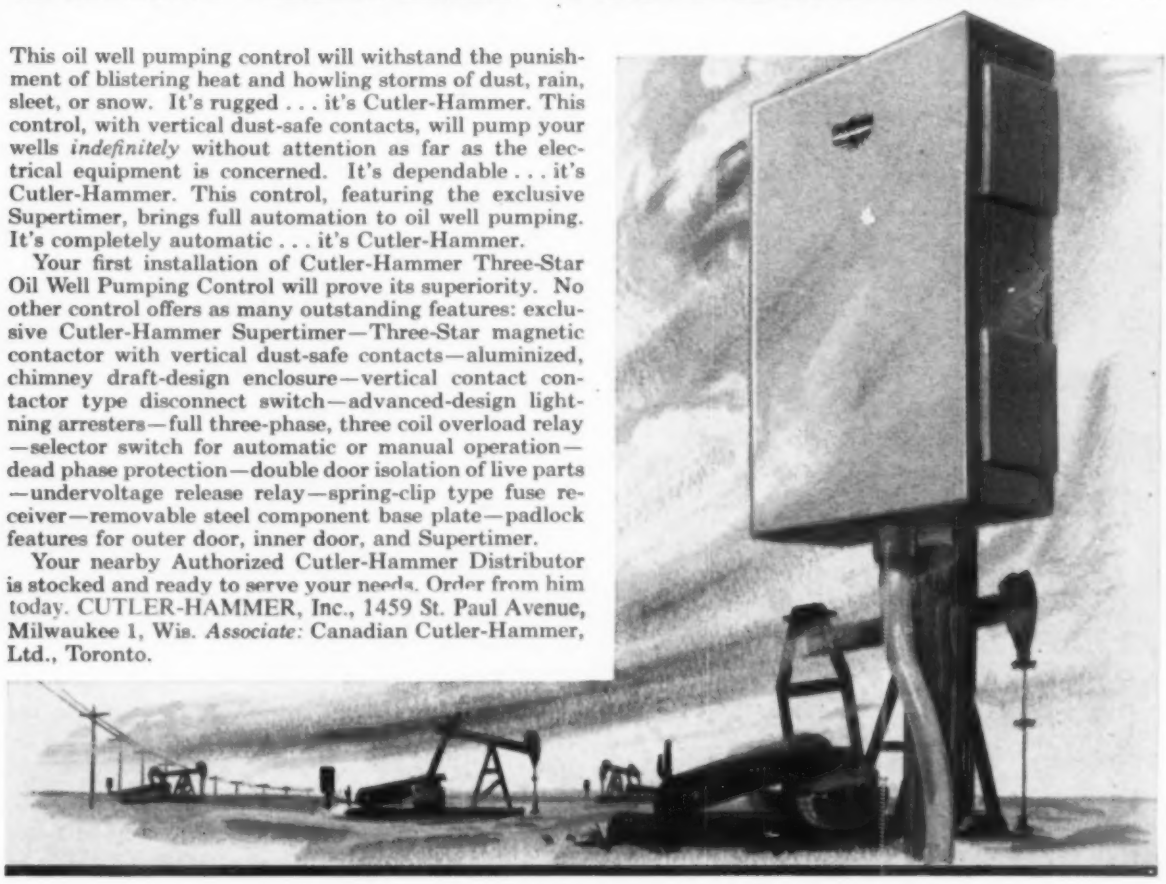
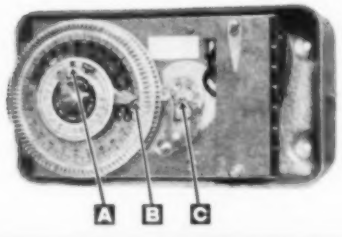
RUGGED. . . DEPENDABLE. . . COMPLETELY AUTOMATIC. . .

This oil well pumping control will withstand the punishment of blistering heat and howling storms of dust, rain, sleet, or snow. It's rugged . . . it's Cutler-Hammer. This control, with vertical dust-safe contacts, will pump your wells *indefinitely* without attention as far as the electrical equipment is concerned. It's dependable . . . it's Cutler-Hammer. This control, featuring the exclusive Supertimer, brings full automation to oil well pumping. It's completely automatic . . . it's Cutler-Hammer.

Your first installation of Cutler-Hammer Three-Star Oil Well Pumping Control will prove its superiority. No other control offers as many outstanding features: exclusive Cutler-Hammer Supertimer—Three-Star magnetic contactor with vertical dust-safe contacts—aluminized, chimney draft-design enclosure—vertical contact contactor type disconnect switch—advanced-design lightning arresters—full three-phase, three coil overload relay—selector switch for automatic or manual operation—dead phase protection—double door isolation of live parts—undervoltage release relay—spring-clip type fuse receiver—removable steel component base plate—padlock features for outer door, inner door, and Supertimer.

Your nearby Authorized Cutler-Hammer Distributor is stocked and ready to serve your needs. Order from him today. CUTLER-HAMMER, Inc., 1459 St. Paul Avenue, Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto.





NEW CUTLER-HAMMER Supertimer

This is automation in action. You pre-set the Supertimer to meet your field allowable and the control will do the rest, automatically. It starts, stops, re-starts and cycles indefinitely, precisely according to your schedule. If a power outage occurs, any number of C-H controlled pumps are automatically restarted in an exact sequence to avoid overloading the power lines on inrush. Unfortunate coincidental starting of even two pumps is impossible.

- **A** Sets the precise restarting time delay from zero to 180 seconds. This is exclusive with the Supertimer—unfortunate coincidental starts of even two pumps are impossible.
- **B** Sets the daily pumping schedule—pull a tab for each fifteen minutes of pumping, space them through the daily 24 hour period as desired.
- **C** Sets the weekly pumping schedule—1, 2, 3, 4, 5, 6 or 7 days per week as desired.

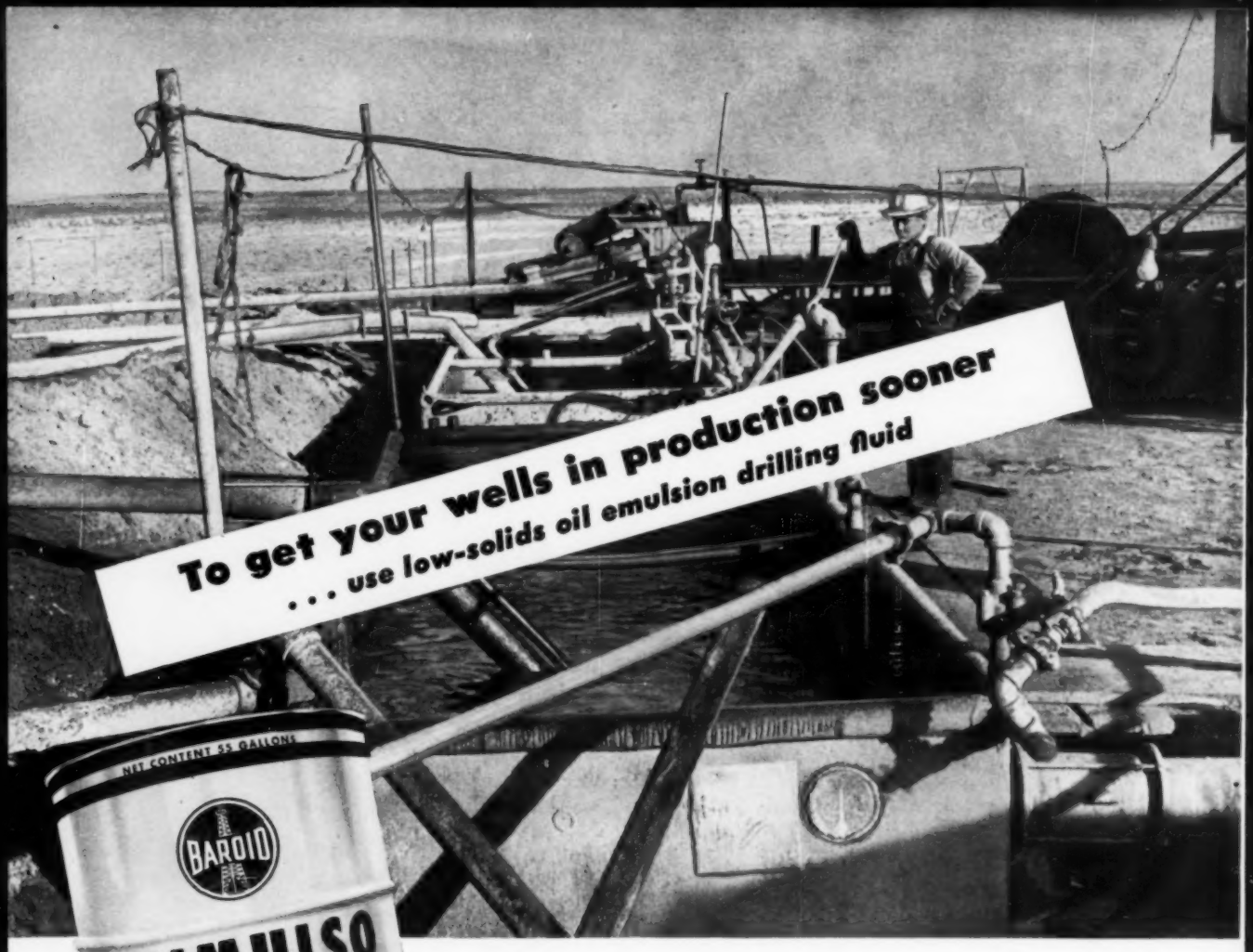
Member American Petroleum Institute

CUTLER-HAMMER ★ ★ ★ MOTOR CONTROL C-H

COMPLETE PROTECTION. The control is protected against lightning with exclusive, advanced-designed lightning arresters; and the three coil overload relay protects the pump motor from overloading and dangerous single phasing which often results from lightning.

CHIMNEY DRAFT VENTILATION. The heat-reflecting, aluminized enclosure insures a constant circulation of air . . . no nuisance tripping because of trapped heat.

DUST-SAFE CONTACTS. Dust-Safe vertical contacts stay clean and eliminate the necessity of contact replacement.



New wells are being completed faster because of longer bit life, increased penetration rates, and fewer rotating hours by the use of low-solids oil emulsion drilling fluids using Aquaness emulsifiers.

PROVED IN OVER 500 WELLS throughout the Mid-Continent areas, this fluid has been a big factor in today's trend to reduce drilling costs. It's outstanding for these advantages:

CLOSER TO GAUGE . . . less cement needed

BETTER CUTTINGS AND CORES for geological examination

REDUCED LOST CIRCULATION PROBLEMS . . . lower mud weights, less hydrostatic pressure

REQUIRES LESS SUPERVISION WITH TRIMULSO . . . the mud flows like water. Solids drop out quickly. Viscosity is easily increased or decreased.

SEE YOUR BAROID SERVICE ENGINEER FOR TRIMULSO*

The emulsifier for low-solids fluids. It's made with Aquaness emulsifiers, the *original* high-speed-drilling-fluid emulsifier.

*TRIMULSO Trade Mark—Registered U. S. Patent Office. Baroid Div., National Lead Company.

LOOK FOR THE AQUANESS SEAL

It identifies the original high-speed, low-solids drilling fluid emulsifier, made by Aquaness for leading mud companies.

ATLAS

Aquaness *Department*

ATLAS POWDER COMPANY

2005 Quitman Street, Houston 26, Texas

here's how Baash-Ross

PRODUCTION SAFETY JOINTS

assure important savings in production operations . . .

INSTALLED ABOVE THE PACKER—where production packers are used—to permit positive release of a tubing string should the packer become stuck.

PERMIT SELECTIVE release and maximum recovery when one or more is used in the tubing string where sanding conditions exist.

ALLOWS CHANGE in production methods quickly and easily without disturbing the packer when installed in the tubing string.

For further information write P.O. Box 1548, Houston 1, Texas or see The Composite Catalog.

BAASH-ROSS PRODUCTION SAFETY JOINTS are run in the tubing string to provide a positive means of freeing the string at the point where the Safety Joint is installed. They are designed with a unique locking type lug which permits heavy rotational loads to be transmitted through the Joint without loosening or overtightening it—yet disengagement can be made with approximately 5 turns by following a simple sequence of operations. Buy through your supply store.

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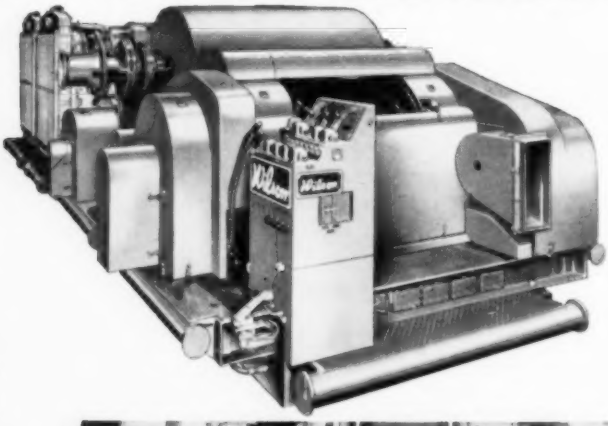
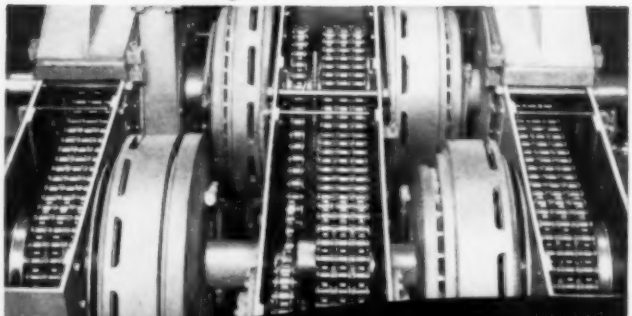
Performance Comes First With **WILSON!**





THE ROLLER CHAINS ARE DIAMOND!

Wilson and other leading rig manufacturers know through long experience that Diamond Roller Chains' uniform high quality gives reliable *drive performance.* This superior drive performance is vital to overall operating economy and helps earn a reputation of performance for the entire rig.

Diamond Engineers have more than 67 years of specialized experience to draw on in helping you solve your power transfer problems. This experience is yours without obligation. Write Diamond for details.

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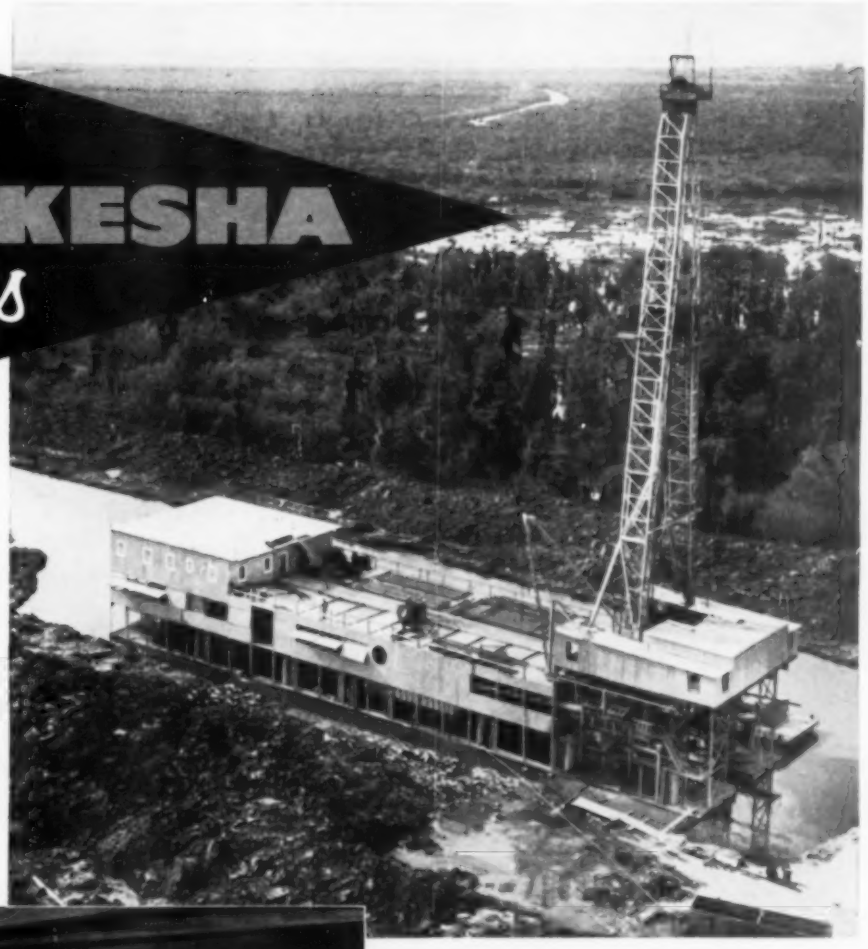
DIAMOND

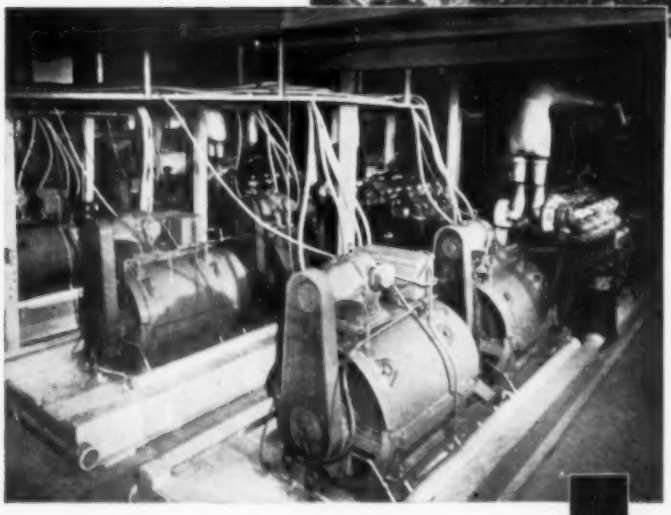
ROLLER CHAINS

five WAUKESHA Diesels

on RIG 6 of the CIRCLE DRILLING COMPANY

SUPPLY ALL POWER





• Circle Drilling Company's 143-ft. Rig No. 6—mounted on their 52 x 220 ft. barge *Kirk C. Lewis* which operates in water to 18 ft. in depth—is one of the world's largest Diesel-electric outfits. Shown here at Week's Island, La., it is drilling a 17,000 ft. well for Major Oil Co.

Three Waukesha V-12 Diesels—each driving two 540 KW, DC generators—supply power for the Ideco E-2500 drawworks, and rotary; and two Emsco D-1000 slush pumps. These three Waukesha V-12 Diesels are Model VLRDBSU—12-cyl., 8½ x 8½-in., 5788 cu. in., counterbalanced crankshaft—have exhaust driven dual turbochargers for extra power.

Two additional Waukesha Diesels—driving two 200 KW, AC generators—supply power for rig lighting and other auxiliary needs. The mud-mixing pump is an Emsco D-300. These two Waukesha Diesels are Model NKDBSU, 6-cyl., 7 x 8¼-in., 1905 cu. in., turbo-supercharged engines with counterbalanced crankshafts.

Send for Bulletins 1663 and 1634

WAUKESHA Engines and Power Units: 10 hp to 1135 hp—Turbocharged and Normal Diesels • Natural Gas • LP Gas

Get Bulletin 1079

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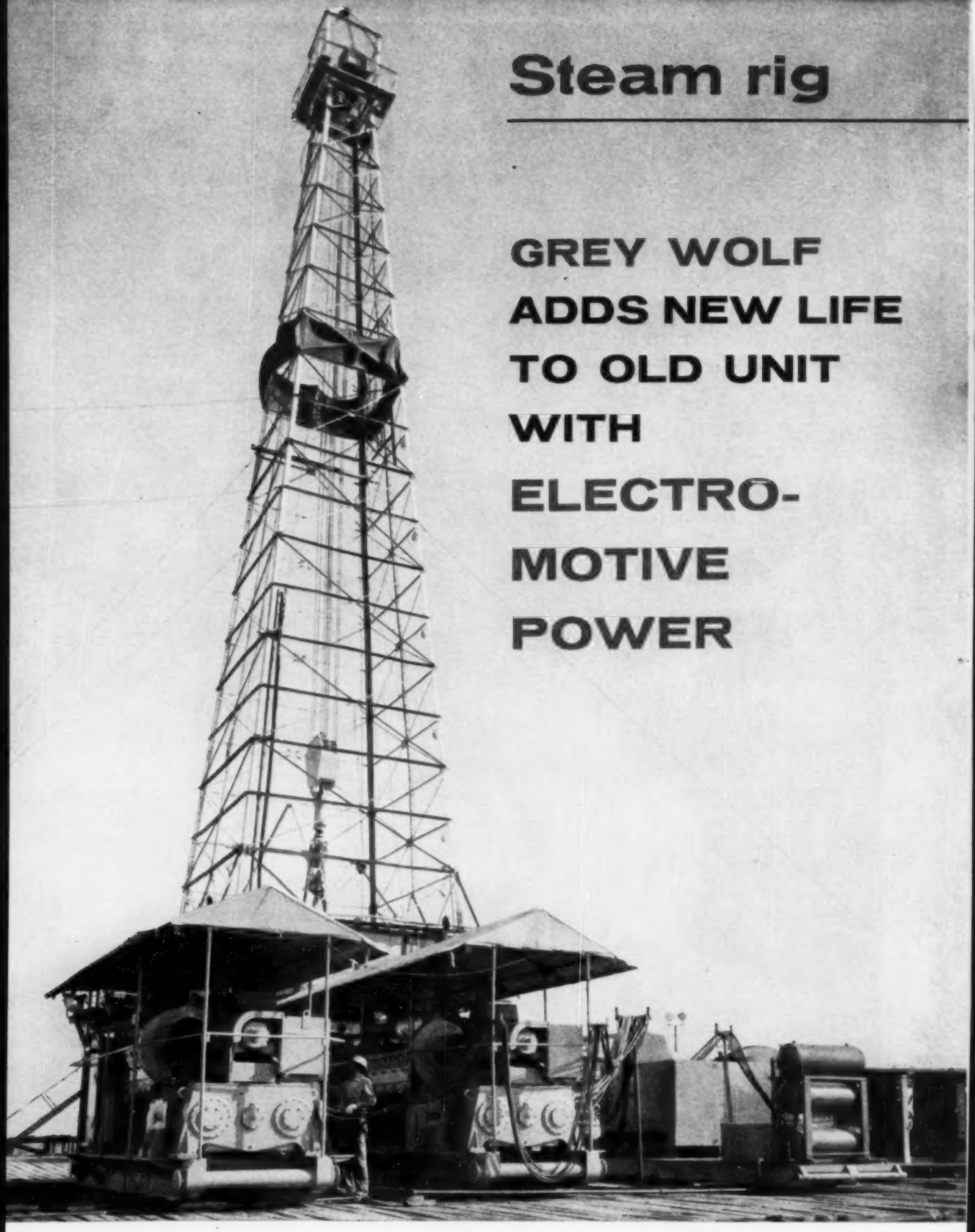
347

Steam rig

GREY WOLF ADDS NEW LIFE TO OLD UNIT WITH ELECTRO-MOTIVE POWER



Two skid-mounted Electro-Motive 875-hp generating sets power Grey Wolf's recently converted rig. Each 8-cylinder engine drives two 500-kw dc generators that supply power to electric drive motors on draw works, rotary and mud pumps. Electrical control cabinet is located on skid to right of engines.

converted to Diesel-Electric

Grey Wolf Drilling Company of Houston expects its newly converted Diesel-Electric rig will cut rig-up time to three days—just half the time it took with the old steam unit.

In addition, "trips" are faster with the new rig and drilling speeds were judged faster on two locations where depths up to 13,000 feet were reached. Maximum drilling depth is well beyond 17,000 feet.

Why Diesel-Electric?

Grey Wolf saw two distinct advantages: Diesel-Electric would adapt readily to present components, thus reduce costs; and because components are connected by flexible electric cables, the rig could be broken into skid-mounted packages for fast transport and quick rig-up.

Why Electro-Motive Power?

A "packaged" system was one reason Grey Wolf decided on Electro-Motive Power. For this system is designed and built to work together—one manufacturer—one source of responsibility. Other reasons were the accurate control and torque characteristics of Electro-Motive Power plus its demonstrated economies of long life and low maintenance on both land and offshore rigs.

Have you considered the advantages of Diesel-Electric for your drilling operations? Contact your Electro-Motive Representative for complete details.

ELECTRO-MOTIVE DIVISION
GENERAL MOTORS · La Grange, Ill.
In Canada: General Motors Diesel Limited, London, Ontario
Petroleum Industry Sales Offices: Dallas and Houston, Texas; Morgan City, Louisiana; Los Angeles, California.

View from derrick floor shows simple arrangement of components on ground. Single 625-hp dc electric motors drive mud pumps. Electric cables run from generating units to various motors on overhead runways. Flexible cables permit placing equipment to fit location conditions.

Driller's control stand provides maximum visibility for every operation. Simple, sensitive controls provide smooth and rapid acceleration of loads with positive control of speed and torque. From this one panel, driller has complete control of all Diesel-Electric equipment.

Over 70 *Locations in the United States and Canada*

McCullough® REPORTS TO THE OIL INDUSTRY

Service *Anywhere Anytime*

New Services • • • New Tools • • • New Methods • • • Outstanding Results

"Carrot-Free" Jet Perforating Developed by McCullough Six Years Ago

Slug-free Glass Jet shaped charges were introduced to the oil industry six years ago. In all these years of use in thousands of wells, and through hundreds of competitive tests conducted or witnessed by oil company engineers, there has never been evidence that carrots or slugs were formed when McCullough Glass Jet Units were fired.

Throughout the years, "carrot-free" jet penetration has been one of McCullough's major advantages. Yet the fact was hard for oil men to believe, because *all other* jet perforating processes did form carrots. Their presence was accepted as an unwanted but natural consequence of the process.

THEN CAME FINAL PROOF—proof so final that many of the other perforating companies were forced to the need of improving their processes. In a recent major penetration research project, McCullough Tool Company was the only service company that consistently shot clean, "carrot-free" jet holes. Others participating consistently produced slugs or carrots that partially or completely plugged the perforations.

You'll hear a lot of sales talk—see a lot of claims about new "carrot-free" jet perforating methods as a result of these tests—but remember, McCullough Glass Jet Units are the *only* shaped charges that have been actually *proved* "junk-free" through six years of satisfactory service.

In addition to being "carrot-free" McCullough Glass Jet Perforators are almost 100% junk free from other sources. The Glass Jet Units completely disintegrate when fired—no metal, rubber or synthetic fragments to plug perforations or leave junk in the hole. Also, after firing the Steel Strip Carrier is removed from the hole intact.

Glass Jets Perforate 7 Zones in 200′ of Formation in 2 Runs

Powerful, Junk-Free Glass Jets in Steel Strip Carriers Shoot 7 Zones for 970 B/D—Lost Production Regained by Use of McCullough Combination Services.

Drilled in 1946, this well was completed by setting 7" O.D. casing on top of the pay zone, drilling into the pay with a 6½" bit and producing from open hole. Recently gas broke into the hole from an adjacent gas injection well and almost entirely killed production.

Operator decided to cement a 5" O.D. liner in open hole below the 7" casing, but, while attempting this, they discovered they had a bad place in the 7" at 2500′. A 5⅜" O.D. McCullough Bridge Plug was set below the bad spot and the hole was squeezed off. The Bridge Plug was drilled out and a combination string of 5⅜" casing with 5" on the bottom was run out into the open hole below the original casing.

A McCullough Radiation Well Log was run, obtaining Gamma Ray and Neutron Curves and a simultaneous collar log. The log revealed seven productive zones spread over 200′ of formation—a total of 150′ of pay zones to be perforated.

Two 100′ Steel Strip Carriers were loaded with Standard Casing Glass Jets, leaving blank sections to straddle unwanted zones, and the 7 pay zones were shot with a total of 600 shots.

The well came in making over 1100 barrels and has settled to a steady production of 970 barrels of oil per day—slightly more than it had originally produced from the open hole completion. The operator was well pleased with the fine results obtained with McCullough Services and, because of bonus production, is programming several wells to be re-worked in the same fashion.

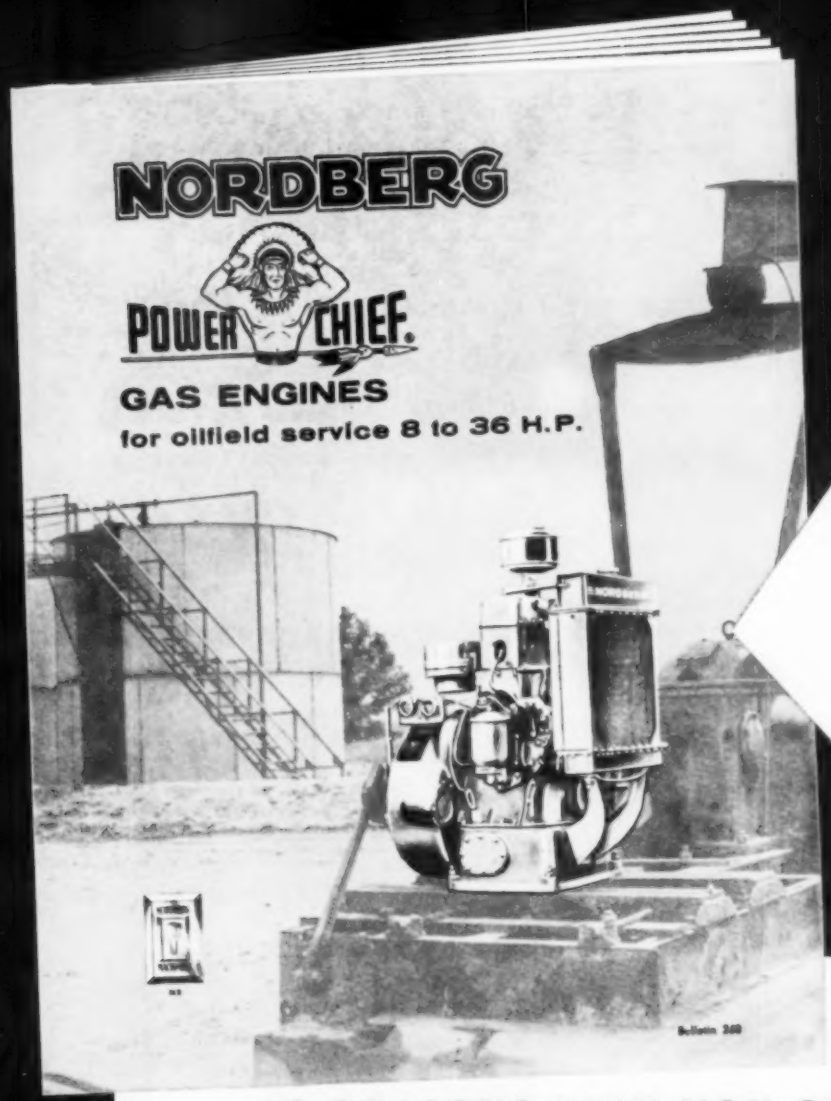
Here is the ONLY jet perforating charge that has been PROVED "carrot-free" and "junk-free" by six years of actual field use—the McCullough Glass Jet Unit.

The versatility of Glass Jet Perforators with Steel Strip Carriers is well-known—the oil industry has been using them successfully for the past six years. The advantage of being able to run extra long Steel Strip Carriers, to straddle unwanted intervals and perforate any number of pay zones in a single run has been proved by hundreds of jobs like the above. Add to this the fact that McCullough is the *only* service company able to offer *proved* carrot-free, junk-free perforating and you've got a perforating value that can't be topped—always specify McCullough Glass Jet Perforators.

McCullough® TOOL COMPANY

Cable Address: MACTOOL

LOS ANGELES
HOUSTON
EDMONTON



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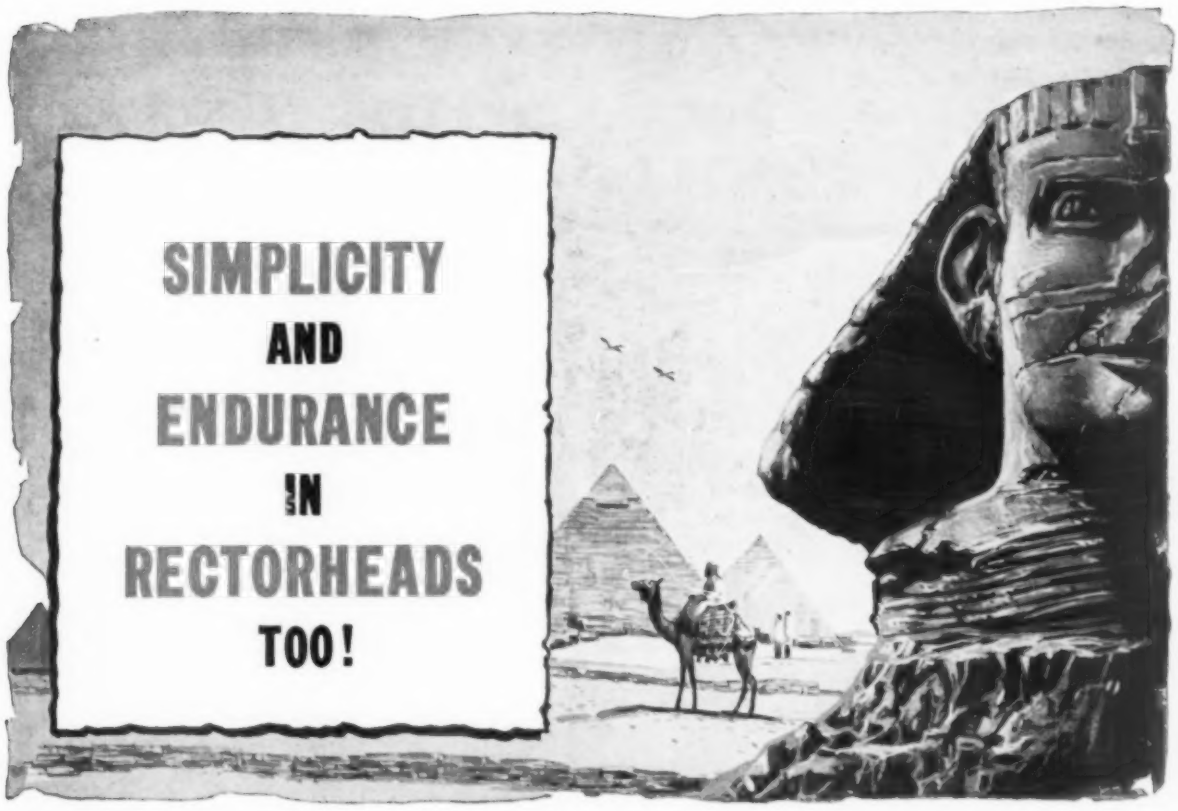

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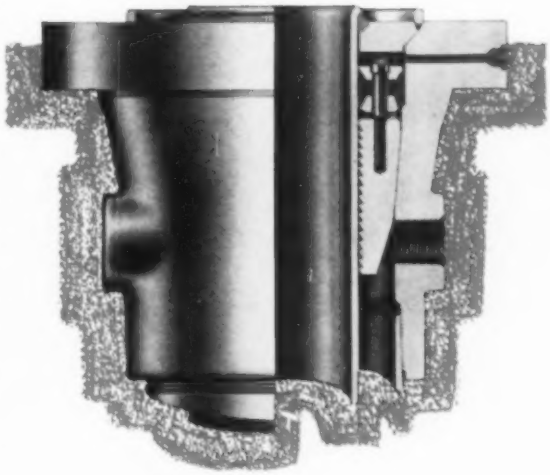

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One of three types of drilling units used in offshore operations by CATC (Continental, Atlantic, Tidewater and Cities Service). This tender-type platform is photographed in East Cameron. — Courtesy Cities Service.

As much as $2.50 billion have gone into offshore operations with only $0.25 billion return . . . Expenditures now run double gross revenue so red figure is still growing . . . Along with highest costs it is also true that . . .

Offshore Offers Best Results

Ira H. Cram

A familiar drama is being played offshore today. As the producing and profit-making potentials unfold through discovery and development, more and more operators are attracted to the area. There are around 50 of them today and many others are tempted. Multiplicity of effort finds oil and gas.

It is the explorationist's job to perfect his end of the business so that an increasing number of operators is attracted to the offshore to supply the multiplicity of effort. Essentially it is a cost-cutting effort with many others in the act, too — petroleum engineers, reservoir engineers, construction engineers, automation engineers, marine engineers, corrosion engineers, drilling experts, marine and air transportation specialists, and practical operators — to mention a few.

Condensation of a paper, "Some Offshore Exploratory Problems" presented before the American Association of Petroleum Geologists annual meeting, St. Louis, April 2, 1957. Complete text will appear in July issue of the AAPG Bulletin.

Early Background

In August 1944, a seismograph party began operations in the Gulf of Mexico off Louisiana. It was not surprising because practically anybody who had been exposed to Gulf Coast geology recognized the prospectiveness of the area.

Let's recapitulate what explorationists were, or may have been, thinking at that time. First of all, according to some observers we were "running out of oil" again. The discovery rate had been declining since the peak year of 1937, and to make matters worse, the API reported that withdrawals in 1943 exceeded new oil blocked out during that year.

Many of the areas that have since made production headlines were not widely considered in 1944 as highly prospective—Scurry County, the Midland, Julesburg, and Williston Basins, the provinces of Alberta and Saskatchewan, to mention a few. Scanning the landscape, it was not hard to conclude that it was timely to start looking offshore even though oil and gas were still too cheap.

Here offshore was an area of 75,000 square miles extending from Brownsville to Key West covered by water no deeper than 120 ft, almost 4½ percent of the nation's hunting grounds. Apparently the most prospective portion of the area was off the coasts of Texas and Louisiana, comprising 27,000 square miles.

Through years of onshore experience, explorationists had learned many of the tricks of exploring and developing this sort of area. And the area was not under lease. Here was something that had

never happened before to an explorationist — 40 percent of a producing province saved for the future by a veneer of water.

It did not take long to learn that some of the guesses were correct — the area could be seismographed at a price, there were structures galore — piercement salt domes, deep-seated domes, and less pronounced structural features all occurring about as frequently as on land. And the surveyors knew where the structures were within reasonable limits.

One had only to buy some leases and drill some wells to complete the exploratory routine. The State of Louisiana rose to the occasion and held a lease sale August 14, 1945, the very day Hirohito decided he had had enough.

There have been no dull moments offshore in the last 11½ years. The results are worth broadcasting.

Exploration Results

As of January 1, this year, 243 new field wildcat wells drilled on 137 prospects had resulted in the discovery of 82 fields, 74 of which are off the coast of Louisiana. Of the discovery wells, 35 are classified as oil fields and 47 as gas fields. So 34 percent of the wildcat wells have produced; 39 percent off Louisiana, only 15 percent off Texas.

Year in and year out the national batting average is a little over 11 percent. Thus, the Louisiana offshore discovery record looks excellent from a statistical standpoint. The record looks still better when one recognizes that a far higher percentage of the Louisiana offshore discoveries are giant fields or probably will turn out to be.

However, one should *not* conclude that a fabulous new producing province has been opened up that will prove to be more productive than the Louisiana-Texas onshore, for instance. Drilling in the waters off Louisiana indicates what most explorers had long expected—geologically the Louisiana offshore is just some more onshore that happens to be covered by sea water. Hence the Louisiana offshore in the last decade was as good hunting grounds as South Louisiana was after the discoveries of Spindletop and Jennings in 1901. With 50 odd years of experience under their belts, explorationists tackled an old problem with modern tools. They have in effect been fighting the Spanish-American War with World War II weapons.

Also it must be remembered that explorationists have been skimming the cream, drilling their most attractive prospects first in most instances. Is it any wonder that the results of exploration in the Louisiana offshore area are exceptional? The Texas offshore has been a disappointment to date.

The first of the year 1185 development wells had been completed. Cumulative production of crude oil and condensate stood at approximately 110 million bbl and cumulative natural gas sales approached 250 billion cu ft. December production of crude oil and condensate was approximately 155,000 bbl a day. Natural gas sales averaged 360 million cu ft per day.

The MER is anybody's guess; the proved reserve is even more of a guess. Consult your own crystal ball on the size of the ultimate reserve. There simply has not been enough drilling to demonstrate the quality of most of the discoveries. As of September 1, 1956, a proved reserve of approximately 620 million bbl of crude oil and condensate and more than 4 trillion cu ft of natural gas was estimated.

On a per-foot drilled basis, the offshore outshines the onshore approximately four to one, whether the total footage is allocated to just crude oil and condensate or to total hydrocarbons.

Other analyses could be presented to support the conclusion that the offshore has proved to be lush hunting grounds. Lest one get the idea that its lushness is perhaps without parallel, it is well to remember that about as many wells have been drilled offshore (1428) as in the Middle East (approximately 1500), that the Middle East's proved reserve of crude oil is estimated by most observers at over 125 billion bbl whereas the possible reserve of the present discoveries offshore can hardly be much over 2 billion bbl, and that on a reserve-per-foot-drilled basis the "magic triangle" of the Middle East outshines the offshore 200 to one.

Investment and Revenue

All the activity mentioned has cost a world of money—$1.70 billion spent on 4¼ million acres of leases, lease rentals, almost 12,500 crew weeks of geophysical work, 1428 wells, together with drilling equipment, producing and transportation facilities. Cumulative gross revenue from production was about $0.25 billion as of the first of the year so the industry was in the red a substantial amount. Also, the industry is still expending about twice as much as its gross revenue from production so the red figure is still growing.

The figure of $1.7 billion for money spent by the industry is in all probability a low one. If figures were available on company research, overhead, and other expense items, and on capital outlays and expenses of the many service organizations working on the offshore problem, one might discover that as much as $2.5 billion have been plowed into the offshore.

Obviously the break-even point is not imminent for the industry. Payout time is far down the road. Certain companies are, of course, closer than others.

Current Problems

Experience to date has been intoxicating. Explorationists have had a wonderful time boasting of their batting averages and reserves — of the reliability of their crystal ball. Companies in on the ground floor have been sticking out their chests. Hard-boiled production men with first hand knowledge of the problems of turning prospects into profits have been less noisy, but even they are pleased that they are now doing the "impossible" such as drilling wells in 112 ft of water as far as 64 miles from shore.

However, the glamor is wearing off. Back breaking work to make back breaking investments pay off is the order of the day. The average offshore well has apparently found 8 or 9 times as many hydrocarbons as the average onshore well and has cost 8 or 9 times as much. Clearly one of the industry's problems is to reduce such costs by

The Author

Ira H. Cram, a director and senior vice president of Continental Oil Company, for many years has been regarded as one of the nation's outstanding petroleum geologists.

A native of St. Paul, Minnesota, Cram was awarded a master's degree by the University of Minnesota, and has served as president of the American Association of Petroleum Geologists. He has had distinguished experience as a geologist throughout the United States, Canada, South America, and Africa.

In 1949 Cram left The Pure Oil Company to join Continental as vice president and manager of exploration. He was elected to the board of directors in 1952, and in 1953 was elected senior vice president.

He is also president and a director of Sahara Petroleum Company; president and a director of Conoco Somal, Ltd., and a director of Hudson's Bay Oil and Gas Company, Ltd., and of Conorada Petroleum Company. These four affiliates and subsidiaries of Continental Oil Company operate in Egypt, British and Italian Somalilands and Canada.

drilling cheaper wells and fewer dry holes.

No. 1 task is to find the oil patch on the structure by drilling a fewer number of exploratory wells. Progress in this direction has already been made — witness the fact that as of September 1, 1956, 77 percent of the fields had been discovered by the first wildcat. But what about the many prospects that have been drilled dry to date?

Brilliant is the explorationist who knows when to quit drilling on a structure that can't make the grade! More brilliant is the man who did not lease it in the first place!

A shade less important is the No. 2 task — developing the fields by drilling a minimum number of development dry holes. The overall dry hole record offshore has not been good. To date 25 percent of the development wells have been dry and 32 percent of total wells. During approximately the same period, 38 percent of all wells in the United States and 34 percent of all wells in Louisiana and Texas were dry.

Statistically the offshore does not look too bad until one takes into account the far greater cost of offshore wells.

Admittedly, piercement domes and wide spacing increase the dry hole hazard. Also, the necessity of decreasing the number of dry holes is not exactly in harmony with the urgency to step out and drill more development wells in order to build revenue and hasten the date of pay-out. Because of the cost of wells, it is prudent to proceed most cautiously in the development of a field. The number of dry holes might be increased by stepping out too fast. Nevertheless, there is big money in quicker payouts so there is pressure to develop rapidly and drill fewer dry holes at the same time. That's a large order.

A larger order is making new leasehold investments today with acreage prices headed for the sky. Fortunately the geophysical cost of finding a prospect worth leasing is still relatively low. An operator can seismograph the offshore out to a water depth of 120 ft for some $15 million.

Finding an unleased structure that has a relatively good chance of being a giant field for $150,000 is cheap today — average onshore costs must exceed $1 million by far. The operator who shot the offshore early in the game found first class unleased prospects for $60,000 to $75,000 each. A high percentage of these pronounced uplifts have and will produce hydrocarbons in some quantity; in fact, an explorationist can put his finger on an oil or gas field — a hat full of them at that — with more assurance offshore than in any other area in the United States, *maybe in the world*.

When leases are cheap the explorationist corrects for his imperfect judgment by buying leases on a large number of anomalies, thereby spreading his bets. When leases are as expensive as they are now — recent lease prices average around $380 per acre and range to over $2000 per acre — the price of such a spread may well be beyond the means of even the giants of the industry. That is why numerous groups of operators have sprung up.

One company's experience will drive home the problem posed by rising lease costs. This company's net interest in almost 664,000 offshore acres amounts to a little over 215,000 acres costing less than $20 million. Most of this acreage was purchased prior to 1953. The company was able to spread its bets over a large number of structures at reasonable cost.

Today the company is represented by leases in 24 producing fields—some of them giants. Today the same $20 million might buy only one 10,000-acre lease on a seemingly first class prospect.

Toughness of the job is somewhat softened by the presence today of a goodly number unleased pronounced uplifts. Some day they will all be leased up and then the job of making a new investment will be far more hair raising.

Improvements Needed

It is well to keep in mind that the cost of finding and developing reserves always varies among operators. Certain components of the total cost such as the monthly cost of operating a seismograph or a drilling rig do not vary widely. The biggest variables eminate from exploratory decisions such as the decision to buy Block A rather than Block B. Offshore where the price tag on everything is high, the necessity of making the most precise exploratory decisions possible in order to increase overall efficiency is obvious.

Perhaps no group of explorationists ever had so many geological data at their command at this stage of the development cycle. Many are armed with broad reflection seismograph coverage, detailed refraction work on shallow piercements, considerable gravity work and well logs made by the most modern devices. All this is a step in the direction toward further perfection of tools, procedures, and concepts.

Improvement in instrumentation will help in the business of making the offshore pay better, but interpretation of measurements made by the various gadgets is of equal or greater importance. Progress has been made in the mapping of faults and salt plugs by seismic means, but further progress in interpretation is a must.

More accurate mapping by geologic means is of equal necessity. Thorough observation and interpretations of the structural, stratigraphic, and reservoir data revealed by each well drilled puts meat on the bones of the structural skeleton furnished by seismic methods.

Another procedure of greater force and effect is cooperation among geologists, geophysicists, petroleum engineers, reservoir engineers and others in the picture. Constant study of each scrap of new and old information by these individuals is necessary but insufficient. Fusing the various interpretations into a single interpretation upon which to base business decisions is the next and vital step. This requires perfect communications and understanding.

The seriousness of offshore problems should push geologists, geophysicists and engineers into the desired degree of cooperation. The resulting technological advance will be of immeasurable service to the petroleum industry. The application of such improved skills elsewhere will result in finding more hydrocarbons — perhaps in quantities exceeding the offshore.

Importance of Offshore

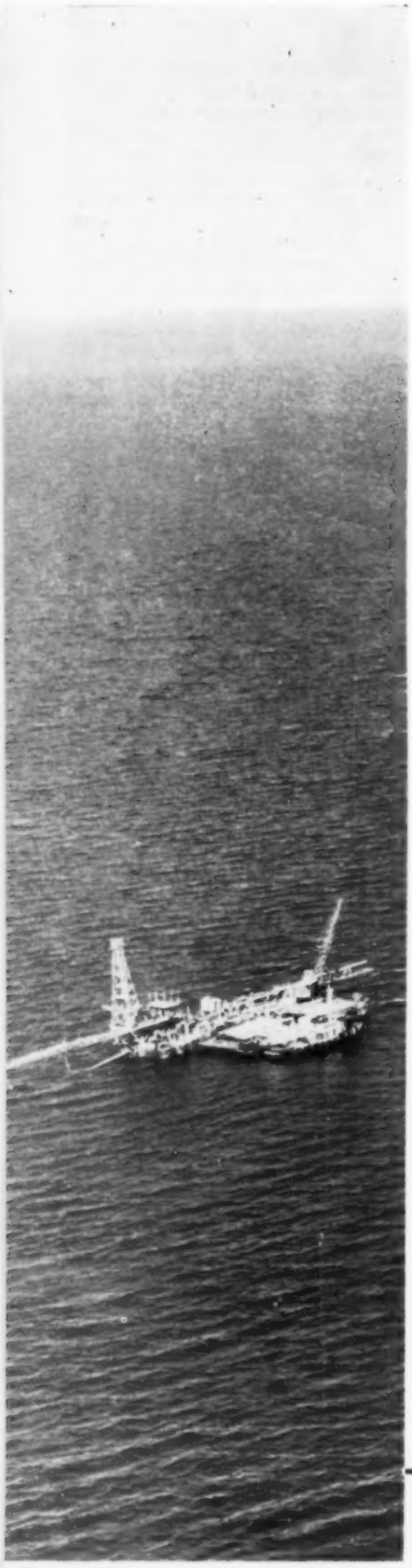
If offshore explorationists need further encouragement to make the supreme effort, they need only to reflect on the relative importance of the offshore in the overall exploratory task ahead.

The American public's voracious appetite for both liquid and gaseous hydrocarbons shows no signs of decreasing. The rest of the world has a growing appetite, too.

Barring economic and political calamities, oil men will have to find far more petroleum in the next decade than in any previous decade; perhaps as much as 55 billion bbl of petroleum liquids and over 180 trillion cu ft of natural gas.

Considering the 9-year period 1947-1955, inclusive, new hydrocarbon reserves found in the United States increased generally throughout the period. But comparing the first 3-year period with the last 3-year period, one finds that it was necessary to drill 43 percent more wells — and deeper wells — to find 13 percent more hydrocarbons during the latest period. Hence, new reserves per well, or per foot or per dry hole, have been decreasing. This is not to suggest that the finding of hydrocarbons is over the hump in the United States — I don't believe it is — but to emphasize the immediate importance of any new area capable of providing new reserves in quantity such as the offshore. ★ ★ ★

What Top Management Says



OFFSHORE operations are getting top attention from management this year. The fact is revealed in the special reviews devoted to exploration, drilling and development of offshore areas in annual reports of oil companies for 1956.

This is the first time that most of those with offshore leases made specific progress reports on over-water operations.

Royal-Dutch, which has drilled over 300 offshore wells in the Lake of Maracaibo, the Gulf of Mexico, the Persian Gulf, and the Gulf of Paria off Trinidad, philosophically stated:

"It might be thought that drilling in deep water could now be regarded as a routine operation. In fact, however, conditions of weather, sea bottom, and depth of water vary so widely from place to place that each different area continues to present its own engineering and economic problems."

The report goes on to tell about the many services required to obtain the objectives in over-water exploration and production operations. In addition to amphibian aircraft, there has been a steady increase in the use of helicopters. A variety of boats are also used in marine operations.

"There were several significant developments in offshore operations," Humble Oil and Refining pointed out. *"A 300-ft by 90-ft barge with a derrick capable of lifting 250 tons will speed the construction of drilling platforms and the installation of other heavy equipment. Increased use of helicopters has helped to reduce costs for transportation of men and materials. A floating drilling barge, converted from an LSM vessel, was placed in operation in the latter part of the year for drilling core tests to assist in evaluating prospects off the coast of California. Wave-force data obtained during tropical storms in 1956 are being used in designing structures and equipment for offshore operations."*

Humble also gave average costs per well for inland and offshore completion. The company's inland wells averaged 6947 ft in depth and averaged $110,300 in cost. The 41 offshore completions cost an average of $580,400 each, but the report states that 22 of these offshore wells were wildcats with the average depth of 11,185 ft.

Most companies this year did not give their production from offshore properties separated from inland, but Humble showed that 8200 bbl a day came from offshore properties of the company's total 387,800 bbl a day production for 1956.

Offshore problems weren't only in operations and economics. The old bugaboo of control was being fought once more. The offshore area was showing again that it was hard to keep oil and politics apart. Off the shores of the United States in the Gulf of Mexico and in the Pacific there was dissent aplenty.

The report of Socony Mobil put it this way:

"In 1956, a dispute between Louisiana and the Federal Government as to the state's boundary line in the Gulf of Mexico disrupted oil operations off Louisiana for several months. By order of the U. S. Supreme Court, no new drilling or leasing was permitted in the disputed zones from June 11 until October 12, when the United States and Louisiana signed an interim agreement to allow resumption of activities.

"Nearly all of Magnolia's half-interest acreage off Louisiana lies within the disputed zones. However, under an agreement between the Federal and State governments, leases there are and will remain valid regardless of which government is granted jurisdiction by the Supreme Court."

Although the court order set back the 1956 drilling schedule four months, Magnolia and its associates, Continental Oil and Newmont Mining, were able to complete 4 wildcats and 25 development wells off Louisiana. They found 2 new gas pools in previously discovered fields.

Like many companies, Magnolia proudly announced the size of its leases off Louisiana and Texas at year's end. It amounted to 128,000 acres.

Standard Oil of California discussed the West Coast disagreement on offshore leases in its report. This company was the successful giant bidder on the first offshore tract leased by the state, since passage of the enabling legisla-

At left is the Arabian American Oil Company's pipe-laying barge and on opposite page is an offshore well in the Safaniya field, Persian Gulf.

About Offshore Operations

tion in 1955. Humble is a full partner in operations offshore California, with Standard the operator.

"Shortly after this award," the company reported, *"other offshore tracts were withdrawn from bid, pending a review by the legislature of the present leasing provisions pertaining to the submerged lands. The company believes the present lease provisions are equitable and offer proper incentives for development of the offshore areas. It has, with other representatives of the industry, recommended that these provisions be left unchanged until they can be tested and practiced."*

Standard of California increased its production from offshore wells in the Gulf of Mexico to 38,900 bbl daily, which was 35 percent of the industry's total production in this area.

Speaking of the tidelands problem, Pure Oil Company stated:

"Great interest continued in the tidelands area of the Continental Shelf, essentially that part offshore from the State of Louisiana. There were no offerings during the year of tidelands areas by the Federal Government for leasing, due to the controversy between the State of Louisiana and the Federal Government as to ownership. There has been no settlement as to boundary lines between the Federal and State areas. For several months drilling in contested areas was held up. Subsequent agreement permitted the resumption of exploration and development on existing leases."

Sun Oil Company is the most active operator off the Texas coast where it has five rigs running.

High costs had thrown many groups together. One of the most notable is known as the CATC Group. This includes Continental Oil, Atlantic Refining, Tidewater, and Cities Service.

Conoco reported the results of offshore operations as particularly gratifying. Its report stated that to date the petroleum industry as a whole has discovered about 82 oil and gas fields in the Gulf of Mexico, of which 24 are known to underlie in whole or in part, leases in which Continental (and associates) own interest. Additional revenue will be realized, the company believes, under contracts negotiated in 1956 upon the sale of substantial volumes of natural gas from large reserves beneath the Gulf of Mexico. New fields of CATC were Block 62, East Cameron area; Block 176, Ship Shoal area; and new pays and extensions are in Block 192 field, West Cameron area; Block 47 field, Grand Isle area; Block 30 field, West Delta area; and Block 41 field, South Pass area. Continental reports its offshore net acreage as 218,000.

In connection with the group, Atlantic reports this on its offshore operations:

"The span of 10 years in which Atlantic has participated with the CATC group in offshore operations typifies the time element required by exploratory efforts before a development program is usually possible. During these 10 years many exploratory drilling and operating difficulties have been overcome. Even the more difficult jurisdictional problems, which have caused considerable delay in the past, are being solved so that we can expect future drilling programs in these offshore areas to proceed on a more normal basis.

"The rewards attained so far from these offshore efforts indicate promise of an overall profitable venture.

"Reserves of both oil and gas per well attributable to these operations far exceed acreage reserves found on land in the United States. Deliveries of gas have already commenced from an area in the Louisiana Delta region and three additional delivery systems for areas farther offshore are scheduled for the latter part of 1957. This revenue and the increases from new wells as they are completed will serve to cushion the effect of cash requirements for the CATC offshore program which has been expanded to the use of 17 drilling rigs."

Cities Service points out: *"The Gulf of Mexico offshore area is potentially one of the most important new sources of undeveloped oil and gas reserves in the Western Hemisphere."*

Tidewater divides its total exploratory wells completed into onshore and offshore. It lists Block 47 as one of the most outstanding discoveries and says that additional step-up drilling is on the program in 1957 in this extensive field, which is 12 miles offshore in 70 to 110 ft of water on a 51,580 acre unit.

An active exploratory program in the Gulf of Mexico is mentioned by

Seaboard. The company owns interest in three offshore wells drilling in the first quarter, and has a half interest in a fourth well, which is scheduled for the second quarter of 1957.

Ohio Oil Company reports that it and its associates (Pure, operator, Sun, Seaboard, Continental, Cities Service, Tidewater and Atlantic) are exploring the East Cameron No. 12 Salt Dome prospect. Ohio was one of the early explorers in offshore areas.

Sinclair, Sohio, El Paso Natural Gas and People's Gas reported on two highly significant discoveries in which they were interested. One was in Block 175, Eugene Island area, which tested 411 bbl a day, and the second in Block 86, South Timbalier area, which had an initial potential of 372 bbl a day. Confirming development wells have been completed on both Block 86 and Block 175. The program for 1957 also includes exploratory drilling in other structures in the Gulf on which the group holds leases.

Sohio's report points out that the discovery well in the South Timbalier area is producing from 12,100 ft. It is 24 miles offshore.

Kerr-McGee et al discovered a new sand in the Main Pass area, Lease No. 1272. The well flowed 4280 Mcf of gas per day and ungaged amounts of distillate.

A wildcat in Block 30 of Ship Shoal area off Terrebonne Parish was brought in as a gas condensate discovery. It established a new flank producing sand for this large piercement-type salt dome, that hitherto has produced oil primarily from the super cap sands. Open flow was 6750 Mcf of gas daily. Phillips Petroleum holds an interest in this area.

Union Oil of California reported on its venture with Pan American Petroleum (Stanolind) which drilled an exploratory well in the Gulf of Mexico. It blew out of control while drilling and was subsequently killed by a relief well located nearby. Union holds nine sections under lease around this important discovery. Concerning the offshore area of California, the Union report stated:

"The future outlook for this region appears very promising, although leasing has been halted until the state legislature reaches agreement on proposed legislation."

Standard of Indiana reported:

"We continue to make selective purchases of offshore leases in the Gulf of Mexico and to use contribution, or farmout arrangements to help process our offshore holdings. One of these contribution wells resulted in a gas discovery. . . . We completed two additional successful wildcats on four interest leases in this area. At year end our total holdings offshore in the Gulf of Mexico amounted to 108,000 net acres."

Shell Oil reported that its crude oil production from fields in the waters off Louisiana was increased to 52,500 bbl a day by the end of 1956, out of a total industry production of 150,000 bbl a day. One important new discovery made by this company was at Eugene Island, Block 188, on a Federal lease.

Acquisition of undeveloped acreage has become much more costly, Gulf's report stated, particularly for promising areas, both on land and in the offshore Gulf Coast. It also pointed out that exploration over water is difficult and drilling requires costly equipment of special design. Work continued in the Federal territorial waters of the Gulf of Mexico with Gulf's production of crude oil averaging 1281 bbl a day at year's end. Actual output was limited by availability of transportation facilities.

Phillips Petroleum, which holds 152,200 net acres off coastal Louisiana, has found oil and gas in 18 fields. The company completed three prolific oil producers on its Eugene Island Block, 40 miles off the Louisiana Coast. A gas distillate discovery well was completed on its block in the Main Pass area, 60 miles southeast of New Orleans. On its offshore acreage Phillips at the end of 1956 held full or part interest in 23 oil wells, 14 gas distillate wells, and 14 gas wells. Of these, 18 are shut-in pending marketing facilities.

There are many offshore operations outside the United States. A great deal of overwater exploration work has been done also.

In 1956 Royal Dutch-Shell completed its second well 45 miles offshore of Qatar without finding significant oil indications. While the platform was being moved, it was virtually destroyed, by an adverse change in weather conditions.

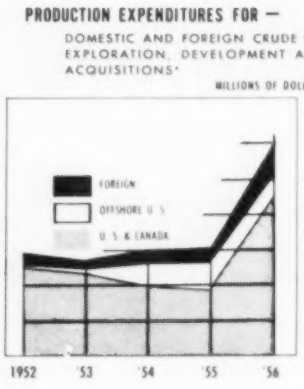
Some 25 miles off Brunei (British Borneo) Shell began drilling from a marine platform in about 30 ft of water.

British Petroleum reported its associate, Trinidad Northern Areas, had found production 23 miles from land in the Gulf of Paria. The company is also preparing to drill in the Persian Gulf off the coast of Abu Dhabi.

Managements of large companies are on the whole pleased with results of offshore operations despite costs.

The glamor has worn off, however, and high costs are bringing closer inspection. So far prices for leases and drilling expenditures have continued going up. Group participation has been one answer. Reports quoted show that most operations include more than two participants.

The breakeven point for Gulf offshore seems to be far in the future but management appears hopeful for long-term success. ★ ★ ★



In this graph in Atlantic Refining's annual report a division of production expenditures shows the sums devoted to offshore operations separately.

*Includes capital expenditures for property, plant and equipment and charges to income for lease rentals, geological and geophysical work and dry hole drilling. 1956 includes properties acquired from the Houston Oil Company of Texas.

Never Underestimate the Power of a Decimal!

In the first sentence of "The Big Offshore Picture — to 1970," in the May issue, Drilling and Producing edition, a decimal point was inadvertently dropped from the estimated proved reserves in the United States offshore fields. What should have been 1.5 billion barrels (a staggering figure in itself) was published as 15 billion barrels (much too much to swallow).

This estimate of 1.5 billion barrels in proved reserves represents additions to 1956 figures up until May 1. These reserve estimates vary from 620 million barrels to as high as 1.8 billion barrels.

J. E. Kastrop,
Editor

Least expensive workover method so far is that involving permanently completed wells and wire line equipment. Truck and station wagon on barge carry all necessary equipment. Jobs with this type equipment cost only one-tenth as much as a conventional workover with a rig. This is Humble's unitized PC equipment on location in the Grand Isle field.

P 532.6

Profit or loss from offshore production may depend upon . . .

Offshore Well Workovers

Application of permanent completions and wire line methods, plus drastic reductions in conventional workovers may be the economic salvation of many offshore wells

WHETHER or not many offshore wells will pay out and show a profit comparable to their onshore counterpart may well depend on drastically reducing the frequency and cost of offshore well workovers. Drilling and development costs of offshore leases is relatively high, as much as 10 times higher than comparable activity onshore. Overhead, due to the nature of marine operations, is abnormally high when compared to overhead of onshore production. While allowables offshore are slightly higher than those onshore, the selling price commanded by a barrel of crude oil offshore is the same as that for a barrel of comparable crude oil produced more cheaply onshore. Since it costs so much more to find, drill and produce offshore oil, the payout period for most wells located in the unprotected Gulf waters has been extended far beyond what is considered to be normal payout in the industry.

Every seasoned operating company with several years experience and with offshore production is now making every effort to reduce drilling and development costs and is taking a serious look into the problem of cutting down frequency and expense of offshore well workovers. Success in each instance will mean the difference in profit or loss for many offshore wells. Since the drilling and development costs of many fields have already been fixed, the remaining economic solution lies in drastic reductions in operating expenses, including those resulting from well remedial work.

Although a majority of offshore wells are less than five years old, sufficient experience has already indicated that the average workover frequency is about three years per well. Or, expressed in another way, an average offshore producer will require some type of remedial work every three years. Operational procedures for offshore workovers are not unlike those employed to work over wells on land. The primary difference is brought about by their unstrategic location in the unprotected waters of the Gulf of Mexico . . . which primary difference adds up to big figures in costs. There has been adequate experience to indicate, at least, the magnitude of these costs. Conventional offshore workovers where a rotary rig was used may cost from about $75,000 for a low figure, all the way up to $275,000. Most offshore workovers will average about $180,000.

For those offshore leases purchased at relatively high values, drilled and completed at high expense, and with overhead and operation costs high, the payout based on present allowable schedules and oil prices may extend for a period of 12 to 15 years.

This is based on a net profit of $1 per bbl of produced oil. This calculated payout does not include additional expenses, such as remedial work. If the well with a long-term payout must be worked over every three years at an average cost of $180,000, the payout period could be extended too far in the future to make it a worthwhile venture.

At this average cost and average workover frequency, based on a net profit of $1 per bbl, the well will barely pay for the workover before it must be worked on again. Figuring on an allowable of 200 bbl per day and a net profit of $1 per bbl, it will take 900 days to pay for a $180,000 workover . . . or about 2½ years. Admittedly, these figures are rough, and every well is a case of its own. However, these findings, based on a study of workover problems in several companies, indicate that it is of a serious nature and does affect many offshore wells.

The economic problem is so serious offshore that some wells located on multi-well platforms were shut in when badly in need of remedial work until other wells on the structure required a workover so all jobs could be done while equipment was on location. This

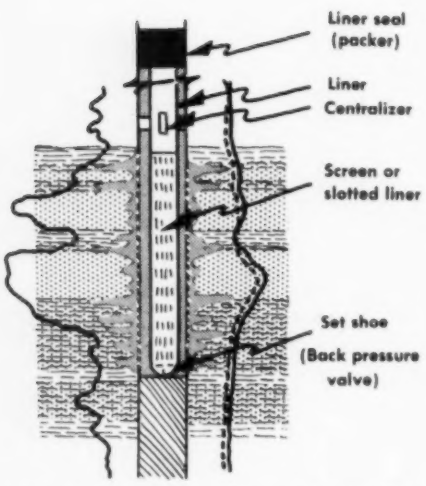


FIG. 1. **Typical gravel pack** to exclude sand. If well was not originally gravel packed, a workover rig is required to do remedial job later. Many offshore wells have been gravel packed to cope with sand problem.

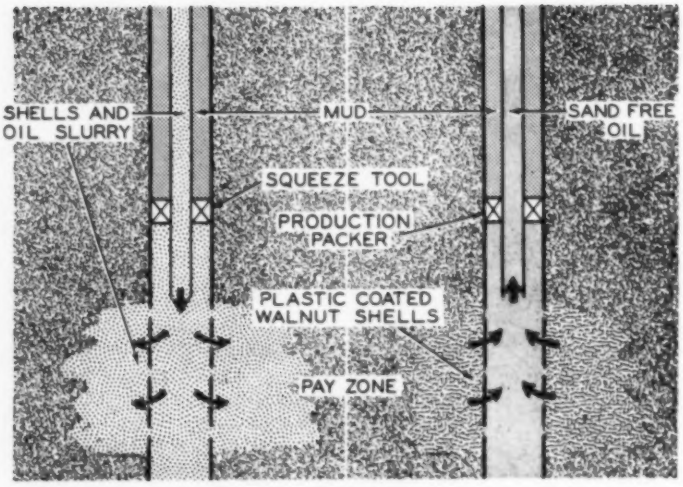


FIG. 2. **Plastic coated walnut shells** squeezed into formation through perforations is a relatively new sand control method. It has been used in initial offshore completions and in later remedial work.

practice may reduce the overall per well workover cost, but when the loss of production is added to the bill, the financial picture becomes darker.

Permanent well completions. Application of permanent completion methods to offshore wells by a number of operators has facilitated well remedial work at minimum cost. Workovers performed by unitized PC service equipment on a number of offshore wells have ranged in cost from $16,000 to $25,000 . . . a drastic reduction from the average expense of $180,000 or even $75,000, the lower range of conventional rig workovers offshore. The primary factor in the cost differential is the elimination of the more costly workover rig, which may run as high as $5000 per day.

Unitized PC (permanent completion) service units are available for offshore well work, and are barged to location. In the past, these units have operated from the barge. However, packaged units have been designed to be hoisted onto the platform with existing booms on the structure. While wire line workovers have their limitations (cannot pull tubing), it is anticipated that their application on wells equipped for a permanent completion will appreciably reduce offshore workovers.

Offshore Well Workover Problems

There appears to be four principal causes for offshore well workovers, which causes are not unlike those which plague wells located in the coastal marshlands. These are:

1. Excess sand production or well plugged by sand;
2. Dually completing an offshore well originally completed as a single zone producer;
3. Plug backs and reperforating, and
4. Corrosion of the tubing string, although this problem is less severe generally due to modern inhibition practices.

The sand problem. A study indicates that sand exclusion is a major cause of well workovers to date. Most offshore production is from the highly unconsolidated Miocene sands which have proven so prolific in the offshore areas. This problem has been attacked from two approaches: (1) Gravel packing, and (2) plastic coated ground walnut hulls which, upon solidifying, form a porous media. Although both methods have met with success, the old sand problem often comes back after extended production.

Some sand production can be tolerated where the sand can be separated and disposed of conveniently. However, in wells that do flow some sand, it is not uncommon for such wells to become plugged up completely after the well has been shut in during a storm or bad weather where it is necessary to evacuate all operating personnel from the field. It appears that sand entrained in the fluid stream in the tubing tends to settle and form a plug. Other types of sand plugs result when the entrained column becomes so heavily laden with sand that the flow is not sufficient to maintain a clean bore and the well sands up.

Whether a well is gravel packed or treated with plastic coated walnut shells depends upon the operator's preference. Some lean toward the gravel pack method almost completely in certain offshore fields, while others use both methods in a given field. In some cases, both methods have proven fairly effective. In other instances, they have not entirely alleviated the sand problem.

Gravel packing. Although there are several methods of gravel packing, perhaps the most popular is that of the pressure pack technique shown schematically in Fig. 1. Gravel is spotted in the bore hole adjacent to the producing formations with fluid pressure and by the use of a drill fluid that will permit partial or complete loss of returns to the formation during placement. By applying fluid pressure and reciprocating the drill pipe or tubing, gravel is forced through the perforations against the sand face, along bedding planes and into fractures. Sufficient gravel is used to fill up the casing above the perforations. Tubing or drill pipe is removed and the screen liner assembly is run in on tubing and washed in place. Several modifications of this method include the use of squeeze tools during placement and various prepared fluids.

Although gravel packing service units are equipped with all facilities to treat a well, the tubing must be pulled. In such gravel pack workovers, a rig has been used along with its heavy-duty pumps.

Plastic coated walnut shells. This relatively new development includes injecting ground and graded walnut shells (usually 20 to 30 mesh) coated with unset plastic into the producing interval by means of an oil type carrying fluid. The plastic is allowed to set and the ground walnut shells consolidate into a permeable screen as shown in Fig. 2. The mass inside the casing is

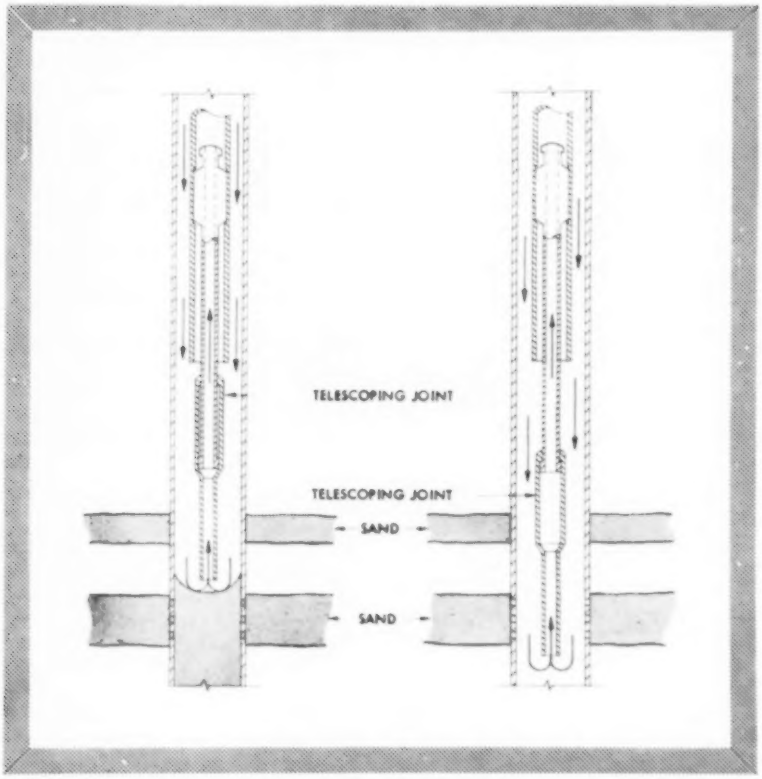


FIG. 3. **Removing sand** from casing opposite producing perforations by means of telescoping extension tube. Well is equipped for permanent completion making possible use of wire line methods.

drilled out and the well completed in the conventional manner.

In wells equipped for permanent completions, several sand exclusion jobs employing plastic coated walnut shells have been executed with wire line methods, much in the same manner as a squeeze cement job is performed with this type equipment. The sand exclusion material is squeezed out into the formation through perforations, and the casing washed clean.

Wells not permanently completed require a rig to perform a plastic coated walnut shell treatment. To further improve the success of this method of sand exclusion where a workover rig is used, a new idea has been proposed and is being seriously considered. Instead of washing out the material inside the casing, the plastic coated walnut shells remain, and a screen liner on the tubing is washed into the material before it sets up. This is quite similar to gravel packing by the pressure pack technique. In this manner, the plastic coated walnut shells are not only outside the casing, but form a continuous permeable pack between the casing and the screen liner. Its disadvantage lies in the fact that the screen liner section on the tubing may be difficult to pull out later, and the solidified plastic material inside the casing must be drilled out should additional remedial work need to be done on the same production interval.

Sand removal. When sand plugs up a flowing well, there are two possible cleanout methods. If the well is equipped for a permanent type completion, wire line equipment can be used to remove the sand plugging the tubing. Wells not so equipped can either be bailed or a rotary rig can be used to pull the tubing.

Wells equipped for a permanent completion are provided with a means of establishing circulation between the tubing and annulus at a point above the tubing packer. If sand has covered this circulating port, it must be bailed down to the port. This failing, a rig may be necessary to pull the tubing. But, if the sand does not cover the circulating port and circulation can be established between tubing and annulus, wire line methods can be employed as indicated in Fig. 3 to wash sand from the well.

Dual re-completions. With the offshore trend increasing toward multiwell completions, many former single zone producing wells have been reentered and dually completed. This type of workover, of course, necessitates a rotary rig of sufficient size to cope with the hoisting loads and anticipated pressures.

General procedure in such dual recompletions was to run parallel tubing strings to maintain completely separated fluid flow. Usual practice was to employ permanent completion equipment on the lower zone and a conventional completion on the upper zone as indicated in Fig. 4. Wire line methods could be used to workover the lower zone, but a rig is required to perform any remedial work on the upper zone. In these dual completions, two packers were used, and one tubing string extended through both packers to handle flow from the lower zone. The other tubing string extended through the upper packer only to carry production from the upper zone. Mud was left in the annulus as an additional safety measure to guard against corrosion and possible costly casing leaks by eliminating exposure of the annulus to production.

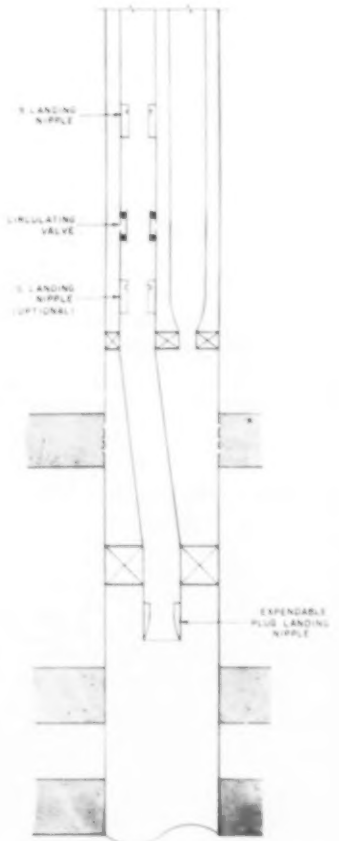


FIG. 4. **Offshore dual re-completions** have included a permanent completion on the lower zone and a conventional completion on the upper zone. Lower zone can be worked over by wire line methods; conventional workover procedures are necessary for the upper zone.

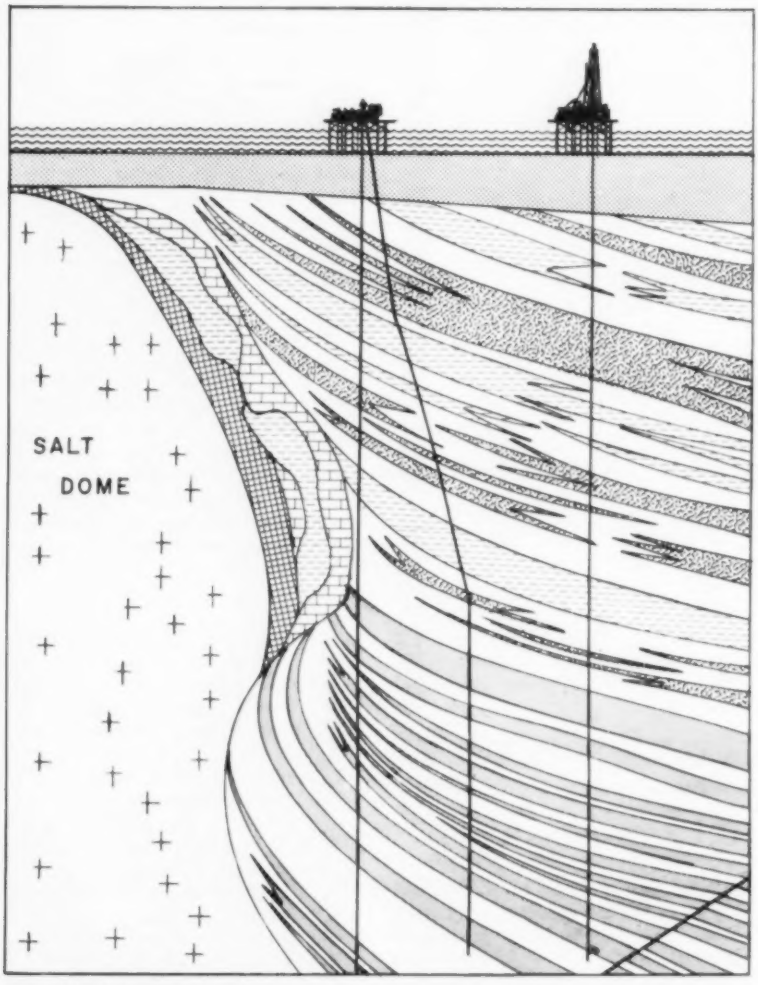


FIG. 5. **Multiple producing zones** adjacent to piercement-type salt dome structures bring about the need of plugging back, one of the predominating causes of offshore workovers. This is a typical example of the geology characteristics of such structures.

Plugback workovers. Remedial work of this type is occasioned when it becomes necessary to plug off one productive interval, reperforate and recomplete the well in another more desirable interval intersected by the bore hole. The multiplicity of productive zones (some wells intersect as many as 22 intervals) in the offshore areas of the Gulf is a common occurrence. In a piercement type salt dome structure, these multiple layers have been intersected by the salt plug and have been tilted as indicated in Fig. 5. Due to the relatively high angle of dip and the character of the reservoir drive mechanism, wells tend to go to high water-oil ratios much faster than other type structures. It has been the practice to perforate and produce the lowermost productive interval in the initial completion. Should this zone later in its productive life begin to produce excessive quantities of water . . . or for other operational reasons . . it will be plugged off with cement and the well perforated and completed in the adjacent upper productive interval.

Well life in many offshore producers has been sufficiently long to bring about such a situation, necessitating plugging back and recompleting in an upper zone. If the original well completion program did not include permanent type completion equipment to anticipate such remedial work, the conventional squeeze cement plug back will be made using a rig. These types of conventional plug back jobs are quite expensive offshore where costs may run as high as $5000 per day. The well must be killed, the tubing pulled, drill pipe and packer run in, cement spotted and squeezed into existing perforations and the casing filled with cement to cover the perforated interval. After the hole is washed, drill pipe is pulled and the well reperforated and completed in the conventional manner.

Should the well be equipped for a permanent completion designed to anticipate such future plug back work, the remedial job is considerably simplified and much less costly. Wire line techniques are used, as indicated in Fig. 6, precluding the use of the more expensive workover rig. The well is killed, generally with salt water, an extension tube run on wire line and cement spotted on bottom and squeezed. Excess cement in the casing is washed out to the desired depth by an extension tube of the proper length. After cement has set the required length of time, a tubing perforator is run and the well reperforated at the next upper interval. Bringing the well in is simple and safe, since all wellhead equipment remains in place. Such wire line plug back jobs have been performed in short order and at a cost of about $20,000 to $25,000. This compares with the cost of a conventional plug back job which may approach $200,000.

Corrosion. In those fields located in the Mississippi Delta area, corrosion has not been an unusual problem. In replacing the tubing, a workover rig is necessary. Corrosion does pose a problem in the gas-condensate fields located further westward, centering in the Eugene Island area. However, special corrosion inhibition programs have been initiated upon completion of these wells, and tubing corrosion is well under control. Replacing a 10,000-ft tubing string can be a costly job since a rig is needed.

Offshore Workover Developments

The workover problem has been under critical surveillance for many years where it represents a significant item in the profit and loss picture of onshore production. From this continuing search for better and cheaper ways of performing remedial work has come a number of proven methods. The permanent completion technique and wire line equipment are perhaps the most outstanding. There have been others to be sure, some of which are used in connection with PC workovers. A collapsible casing plug has been run through the tubing and then expanded and set by an explosive in the open casing below to provide a new, quick and inexpensive plug back method. Once the plug has been set in the casing above the zone to be plugged off, several sacks of cement are dumped on top of it to add additional plugging.

Now that the offshore workover

problem has come into sharp economic focus, serious study is being given to doing something about it. The only difference between offshore and onshore workover problems and practices lies in the marine nature of the former group. Well structures, weather, marine transportation and a host of other characteristics peculiar to offshore locations make the big difference.

Workover rigs. Design of platforms supporting offshore wells varies so widely between operators and also within a single company that no standard exists. This complicated the design of a specialized offshore workover rig that would meet the economic challenge and adaptability of all situations. However, such a rig has been designed and described in another report in this issue (Page B-172), and it holds considerable promise. It is completely skid-mounted, in two main sections, and completely integrated and self sustaining. It is hoisted onto the well structures and pinned together. It can be skidded on the platform to service more than one well. However, it is not applicable for the single well structures that have little or no deck space or adequate footing to support the new rig.

To service the single well units, several mobile submersible drilling barges have been used, and at least one has been designed especially for workover purposes. On the smaller 4- or 5-well structures, the limited deck space makes it difficult to adapt conventional land workover rigs for offshore use. In most cases, they had to be modified, unitized, and compacted.

Wire line units. The past two years have seen the growth of unitized permanent completion service units. These have been mounted on large trucks which can be barged to location. Perforating equipment, in all cases, has been separately contained in a panel-type, light-weight truck. These were primarily designed for onshore use on PC workovers, but have been used on several offshore PC workovers.

Trend today in unitized PC service units for offshore application has been toward skid-mounted equipment. One service company and one drilling contractor have available skid-mounted wire line PC units. Among the latest ideas in skid-mounted PC equipment is a hydraulically-powered packaged unit consisting of eight skids, the heaviest of which weighs only 5800 lb (See Fig. 7). The complete assembly includes:

- Two engine power units, each driven by a 142-hp diesel (rated at 1800 rpm) and each measuring 58 by 112 in. Total weight is 5500 lb per package.
- Two pump units, powered by 128 hp (at 2500 rpm and 5000 psi) hydraulic motors. Each pump is a triplex, one equipped with 1½-in. plungers and one with 3-in. plungers. Each unit measures 88 by 62 in. and weighs about 5500 lb.
- Tank unit, containing 17-bbl capacity stainless steel mixing tank, two 7-bbl measuring tanks and manifold, measures 110 by 96 in. and weighs 2900 lb.
- Wire line unit containing two reels (.092-in. piano wire and 3/16-in. aircraft wire) and hydraulic drive, 60 by 94 in. It is the heaviest single package, weighing 5800 lb.
- Cement storage for 110 sacks, measures 52 in. wide, 96 in. long, and 90 in. high.
- Tool house for wire line equipment, containing 4000-watt hydraulically driven electric generator, change room, etc. is 132 in. long, 96 in. wide, and 97 in. high.
- Also available is a light weight hydraulically driven sack cutter and screw conveyor for handling cementing materials, and a 56-lb water transfer pump. The pump is a 3-in. centrifugal, driven by a vane-type hydraulic motor.

Each skid-mounted package is equipped with a box framework to the corners of which have been attached lifting bails. The weight of each package has been kept below 6000 lb so that they can be lifted from a barge onto an elevated well structure by means of a hand winch and stiff leg boom. The latter equipment is normally found on most offshore well structures.

Exclusive hydraulic power. The

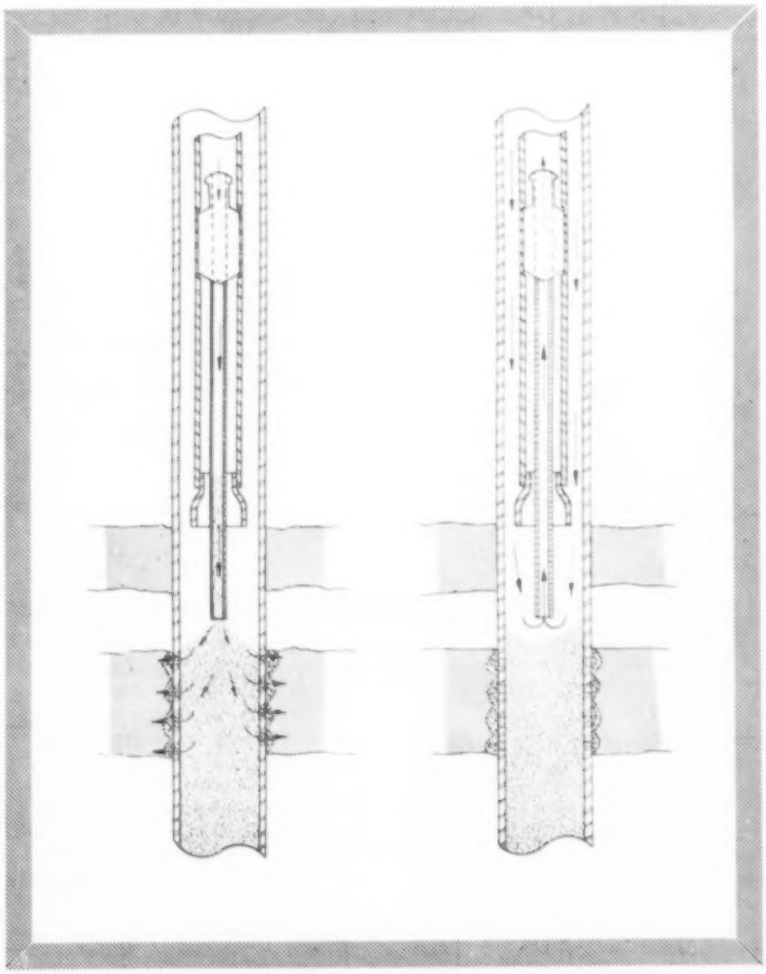


FIG. 6. **Plug back** by means of wire line methods in permanently completed wells may be done at minimum expense. Cement is pumped through extension tube, squeezed and the cement plug cut to desired depth prior to reperforating in upper zone.

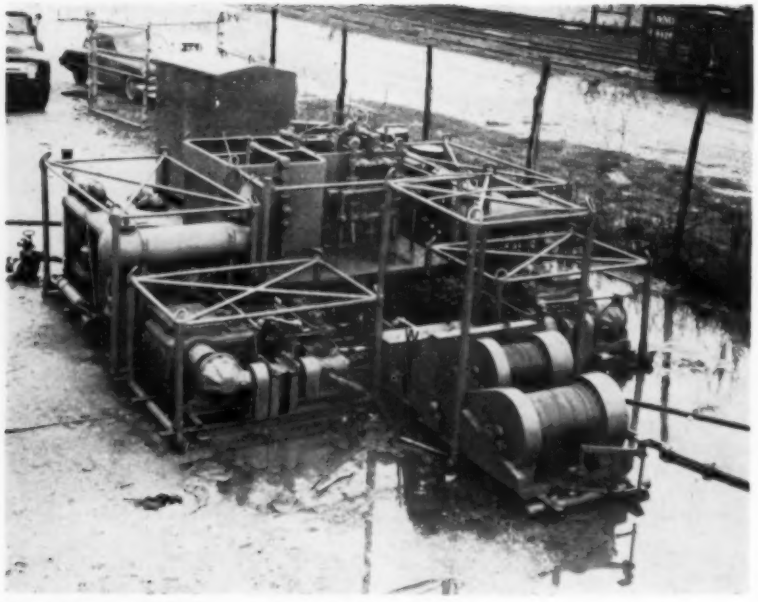


FIG. 7. **Packaged wire line service unit** is newest development to workover permanently completed wells. Heaviest package weighs only 5800 lb.

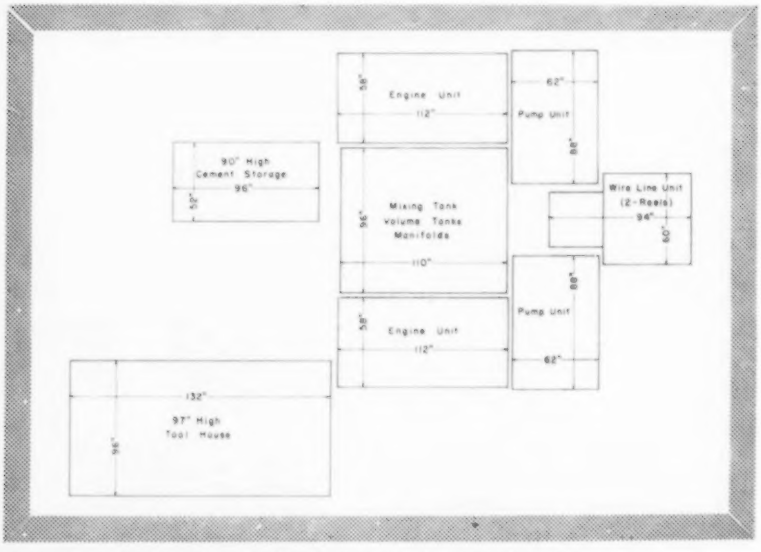


FIG. 8. **Layout of packaged unit** indicating size of each package and overall dimensions required for deck space. Each package may be hoisted from barges to platforms by hand-operated hoist and stiff-leg crane.

power system is completely hydraulic throughout. The two 142-hp engines directly drive variable volume hydraulic pumps. The pumps, the wire line reels, electric generator, sack cutter, and conveyor are all driven by hydraulic motors which are supplied hydraulic pressure through high-pressure hose connected to the manifolds of the two hydraulic pumps. The two hydraulic motors driving the two triplex pumps are of the piston type rated at 128 hp at 2500 rpm and at 5000 psi hydraulic pressure. The wire line reels are powered by a vane-type hydraulic motor rated at 60-hp at 2000 psi.

Controls for the wire line unit are mounted at the operator's position, and consist simply of two knobs which control the pressure and volume of hydraulic oil supplied the driving hydraulic motor. The unit is equipped with the usual braking devices.

Controls for the two triplex pumps also provide for volume and pressure of the power oil. They are connected to a 15-ft section of control hose permitting the operator to remotely control the speed of each triplex pump independently of the other. Both power and pump units have been designed so that the power oil output of either power unit can be connected to either hydraulic motor driving the triplex pumps. Capacity output of both pumps compounded is about 6 bbl per min at about 1800 psi discharge pressure.

The wire line reels of this packaged unit are for hoisting only. The 3/16-in. aircraft cable is for bailing or for making heavy pulls. Both reels have a capacity of about 20,000 ft of cable. The perforating unit was not included in the packaged components as is the case with previous unitized PC workover units. Since it is required for only a short time during the workover, it was provided separately so it would not be tied up along with the packaged equipment described above which will be used for most of the workover.

Future of Offshore Workovers

It appears that a completely satisfactory and economical method for working over offshore wells is yet to materialize for the some 1300 offshore producing wells located in the Gulf. With well remedial problems continually growing in number and in magnitude as the wells gradually become older, more study, field testing and research is getting the serious attention of all offshore operators. Application of permanent well completions, workover equipment such as that described above, and the practical field adaptation of new developments will be needed to cope with the economic problem of offshore well workovers.★ ★ ★

Military Petroleum Advisory Board Appointments Named

Felix E. Wormser has announced appointments to the Military Petroleum Advisory Board by Secretary of the Interior Fred A. Seaton.

Members reappointed are John H. Carson, the East Ohio Gas Company; Stewart P. Coleman, Standard Oil Company (New Jersey); James Terry Duce, Arabian American Oil Company; W. W. Keeler, Phillips Petroleum Company; A. W. Lundstrum, the Ohio Fuel Gas Company; George L. Mateer, Cities Service Refining Corporation, and Richard E. Nelson, Jr., Standard Oil Company (Indiana).

New members are Charles P. Baker, Mobil Overseas Oil Company, Inc.; Walter E. Caine, Texas Eastern Transmission Corporation; Albert R. Denison, Amerada Petroleum Corporation; Jake L. Hamon; Herschel Hyde, Tidewater Oil Company, and Frank A. Watts, Humble Oil and Refining Company.

FIG. 1. **Permanent link** for communications and control between Morgan City offices of Magnolia and Block 126 platform is offered by the company's new offshore microwave system. Outlying drilling rigs and platforms are joined to the system by low frequency VHF radio.

P 599.5

In the Eugene Island area, Magnolia installs . . .

First Offshore Microwave System

Interference-free communication 55 miles into the Gulf, new system offers big potential in automatic production controls for three major offshore fields

C. R. Graham,
Assistant Editor

MICROWAVE is playing a major role in moving production 55 miles offshore and 25 miles overland for Magnolia Petroleum Company. It is proving successful and economical for voice and VHF radio communication on an 80-mile stretch between Morgan City, Louisiana, and outlying platforms of the Eugene Island area in the Gulf of Mexico. The company's new high frequency equipment went into service April 1.

Magnolia's new system is capable of almost unlimited expansion with present equipment set to give 30 private voice channels. Or if desired, this could be changed to as many as 600 telemetering and supervisory control channels. With these, actual routine production tasks would be performed — gaging tanks, taking production tests, putting wells on or off production, switching tanks and running oil. All this in addition to reading and recording production and well data such as wellhead pressures, flow pressures, tank levels — in any weather and completely unattended.

Having just scratched the surface, the company is presently using only two voice channels and a VHF control channel in its testing stage. System consists of five stations, beginning at its

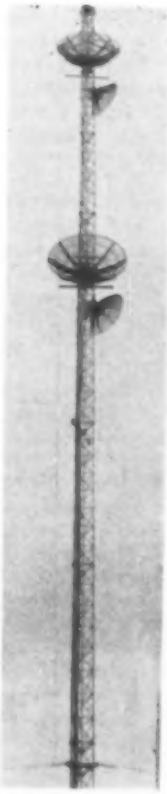


FIG. 3

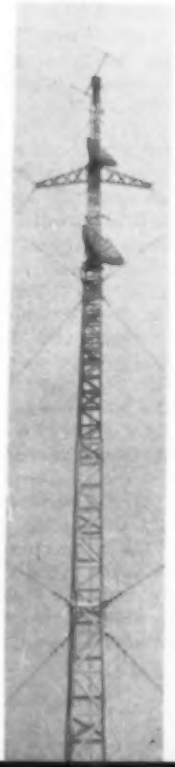


FIG. 2

FIG. 2. **Apex of the Magnolia system** is this 280 ft tower in Morgan City. The company had only to mount parabolic dishes on this tower, already in use by VHF radio.
FIG. 3. **Burns Terminal tower,** 180 ft high, directs microwave communications seaward to the company's three offshore stations.

Morgan City offices, extending westward to Burns Terminal, south out into the Gulf to Block 51, then to Block 126 platform and ending at the Block 128 platform.

Overburdened Offshore Airways

Increased oil activity on the Gulf Coast has brought with it increased traffic and competition for time and space in already cluttered short wave radio channels. VHF (very high frequency) radio congestion and *the* p.. ty-line nature of this most common form of wireless communication prompted Magnolia to look to uncrowded higher frequencies in planning a new system. Figuring its current needs, the company saw an immediate demand for all-weather, interference-free transmission; for the future, it wanted expansion communication facilities at nominal cost. Also desired were telemetering and supervisory control features. These were all found in microwave.

Prior to the installation of this new system, the company used VHF radio on frequencies assigned to the Petroleum Radio Service by the Federal Communications Commission.

Magnolia chose a microwave system designed, engineered, and installed by the Radio Corporation of America. It is now in its final testing stage prior to acceptance by the company.

Use of the System

One of the voice channels of the microwave system is used exclusively for the company's crude oil transfer dispatching functions, while the second channel is used for inter-platform communication in production work. The VHF channel is predominately used by drilling and producing personnel to communicate with outlying rigs and production platforms.

What Is Microwave?

Magnolia's system operates in the 2000 mc (2000 million cycles per second) range, relatively low in the microwave spectrum. Any radio equipment operating above 900 mc is generally considered as microwave. Since these microwaves (measuring 12 in. or less) are so short, they exhibit many characteristics similar to those of light, such as diffraction, reflection, and refraction. These phenomena become more and more pronounced as frequencies go higher and higher. These optical qualities make it fairly simple to focus microwave signals into narrow, powerful beams and project them over considerable distances. This is accomplished by the use of highly directive parabolic transmitting antennas that act like huge lenses on searchlights. A high gain (or magnification) in signal power is affected at each transmitting antenna and again at the receiving antenna, making it possible to project information over a point-to-point relay system with very low initial power. Because microwaves are beamed and not radiated in all directions like conventional radio waves, it is possible to maintain a high degree of privacy in microwave transmission.

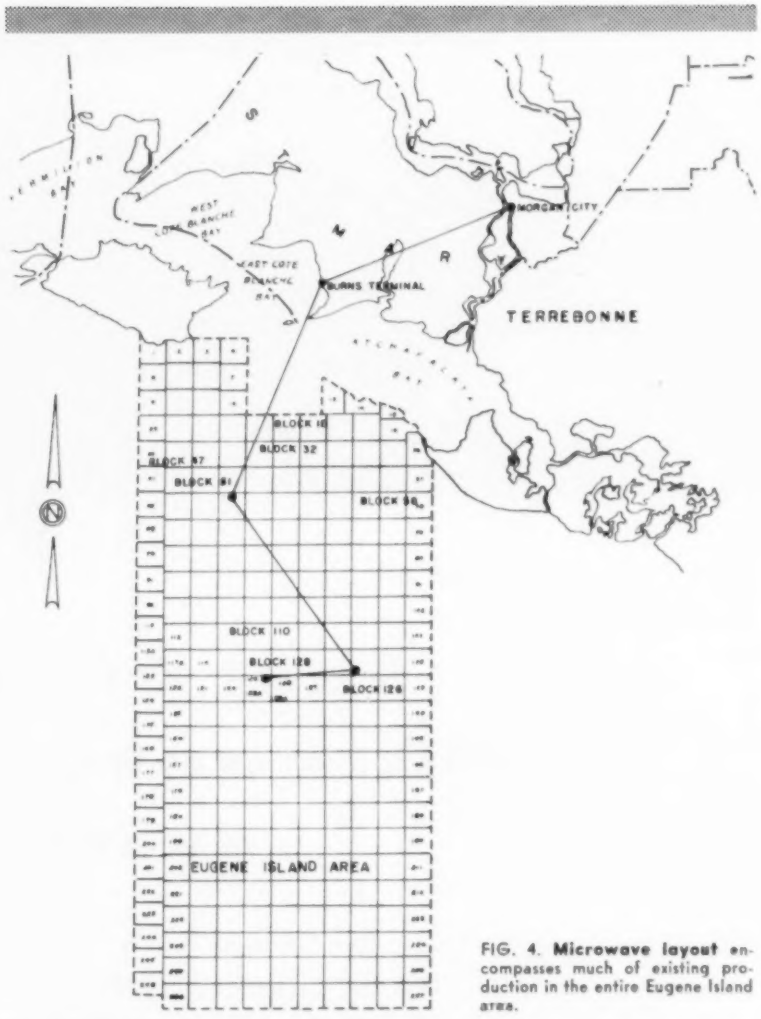


FIG. 4. **Microwave layout** encompasses much of existing production in the entire Eugene Island area.

Beamed microwaves, although following a general line-of-sight path, are affected by several outside factors. Refraction, reflection, obstruction diffraction — even wave bending as a result of variations in density of the earth's atmosphere — are compounded in microwave transmission. Over water, marshlands and flat terrain, for instance, microwave signals are often more susceptible to fading and self-cancellation than in rougher terrain. For these reasons, many have looked with doubt at Magnolia's system — predominately over water. The company, however, reports good operational efficiency.

Magnolia is overcoming much of the fading troubles, normally considered inherent with microwave by transmitting on one and receiving from two antennas, one on top of the tower and one at about mid-mast. Magnolia calls this double-barreled receiving "space diversity."

Space diversity reception has been provided on all paths with dual receiving antennas. The system operates this way: Only one receiver is connected to the microwave system at a time. Should the output of the connected receiver fall below the acceptable minimum, then the other receiver will be immediately connected to the system by the diversity switch—provided it is receiving a signal that is above the acceptable level. Each of these receiving antennas will be spaced on the tower in such a

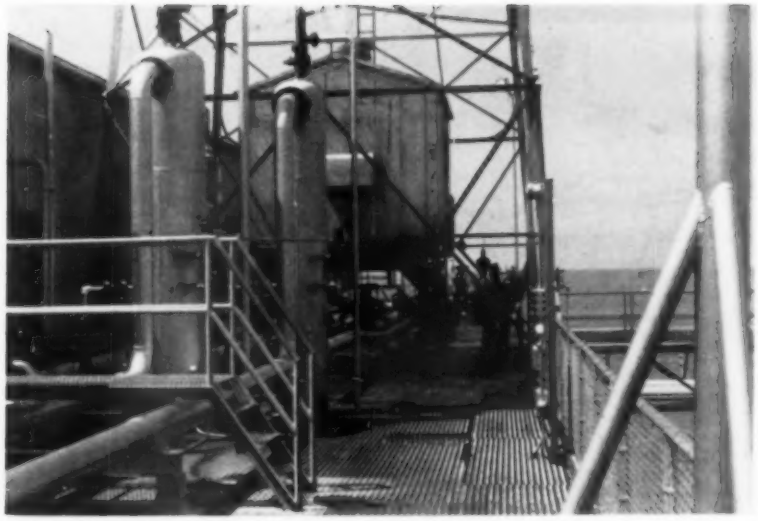


FIG. 5. **Transmitter hut** on Block 126 platform is characteristic of all units. Each repeater station has its own permanent power supply. Hut is completely air conditioned to prevent equipment overheating and permit humidity control.

way that the probability of a simultaneous fade on both antennas is remote.

What It Can Do

Microwave is capable of performing the same functions as a good four-wire telephone system. Microwave permits transmitting and receiving at the same time, while on conventional push-to-talk VHF radio a changeover from sending to receiving is required. To obtain the multitude of services from the voice and/or control channels available through one transmitted signal, however, the higher frequencies afforded by microwave are necessary.

Take Magnolia's system, where as many as 30 voice messages may be sent simultaneously. All these messages are fed into a single "header" at different frequencies. From there the garbled signal goes into a microwave unit that converts it to high frequency and broadcasts it.

When it is received, it is converted into lower frequency, and finally into the individual frequencies of the various channels.

To simplify the process, it works like this: Suppose there were three microphones connected to individual tape recorders. A man with a bass voice reads a message into the first; a woman with a high-pitched voice reads into the second one and a bird with an even higher pitch sings into the third. After the three have been recorded, they are combined onto a single tape. The resulting tape, although garbled, will be broadcast, running it at such a high speed that it sounds much like a screech rather than a garbled message and song.

When the screech is received, it is recorded and when it is played back at slow speed it will sound like our garbled message. Then using instruments that record only low range tones, another for soprano tones and another for extremely high tones, facsimiles of our original message are obtained. This procedure is somewhat similar to microwave, only instead of tape recorders and the like, radio units are used.

'Old Hat' to Pipeliners

Although every man in drilling and production may be familiar with VHF or mobile radio and some production men are being initiated to remotely controlled equipment, microwave is already "old hat" to the pipeline industry. A recent survey by *The Pipeline Engineer* revealed that there are now in operation some 683 stations and 18,500 microwave system miles within the U. S. pipeline chain. Pipelines are far past the stage of using microwave for communications only, having extended its use to include telemetering, remote control of unattended stations, teletype and facsimile transmission and to perform nearly all warning and safety functions.

Many of these controls could be performed by other means, such as through telephone wires or low frequency radio. At this point, cost factors begin to enter the picture. Overland telephone systems require not only line and poles but expensive right-of-way. Offshore, this wire (run in underwater cable) is even more expensive. According to figures recently released by one pipeline company, cost per mile of telephone line over land was above $1500, while cost per mile of microwave system is about $600. Lower frequency radio is often as expensive as microwave, while not lending itself to the multitude of uses or possessing the ability of unlimited expansion at limited extra expense. Microwave, too, offers a practically interference-free system with all-weather reliability and is entirely private.

Magnolia Trims Costs

Estimated costs of the systems have been trimmed by using old 87-ft production workover derricks as towers on its offshore platform station locations. Too, the company is using existing personnel to maintain and operate the system.

Other savings have been noted. At Morgan City, sets of 6-ft diameter dishes are mounted at 180 and 125 ft on a 280-ft tower already in use for VHF radio service. At Burns Point, one set of 10-ft parabolic antennas are mounted at 180 and 120 ft and also a set of 6-ft antennas at 120 and 65 ft. Sets of 6-ft dishes are mounted at 145 and 75 ft on existing platforms at Block 51 and 126 fields. These are points where the 87-ft production workover derricks are used. They are mounted on 20-ft substructures on the platforms that are already 40 ft above water level — putting tops of the towers at 147 ft.

Distances between relay stations have been kept at a minimum. Longest hop on the system is about 24 miles from Burns Terminal to Block 51. Other hops are 19 miles from Morgan City to Burns, 23 miles from Block 51 to Block 126, and 9 miles from Block 126 to Block 128.

VHF Combined with Microwave

By continuing use of VHF radio on rigs and individual platforms in areas in the immediate vicinity of the microwave repeater stations, direct messages may be sent via microwave from Morgan City offices to repeater points and then by VHF radio to individual units. This arrangement lowers VHF power requirement and "frees" the lower frequencies of quite so much traffic.

Microwave Maintenance

Maintenance of Magnolia's system has been simplified considerably by a series of several safety and warning controls inherent to microwave. One such control is a fault-finding channel that will transmit to the Morgan City office trouble in any one of the transmitting units. When this signal comes, it does not mean that the system is entirely inoperative but perhaps just malfunctioning.

System is capable of performing several simple warning functions — such as noting illegal entry into the radio hut, tower light failure, low transmitter

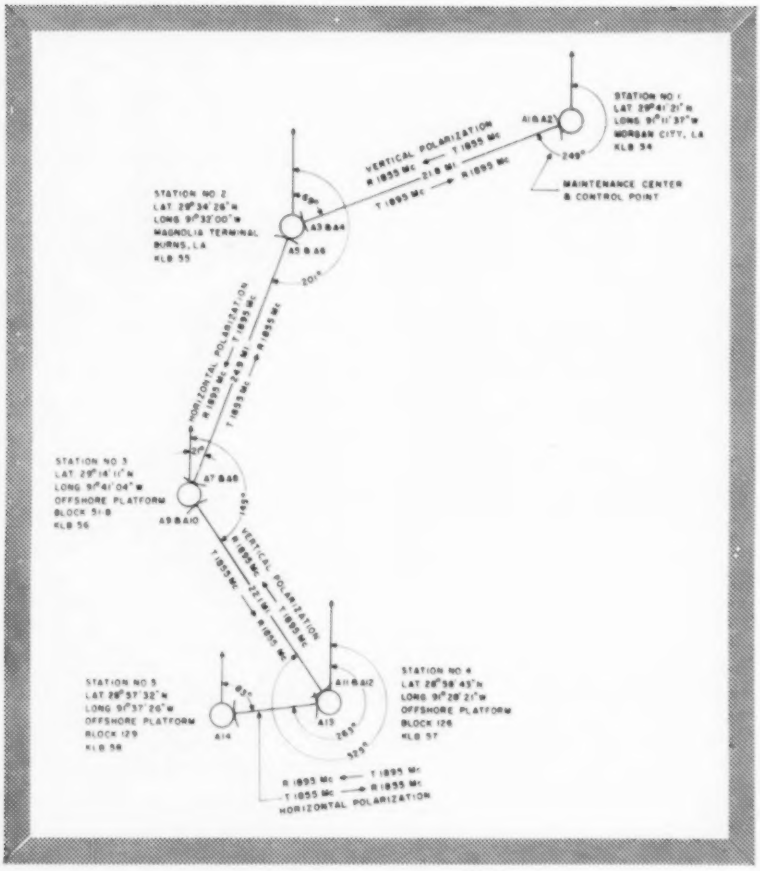


FIG. 6. **Magnolia transmits and receives** on two different frequencies, alternating between stations on each of the four hops.

output, switch to auxiliary power, etc. Magnolia is at present using one of these warning systems.

As a further aid to maintenance, there is a way to intercept trouble before it comes. Each unit in the system has a longevity test button. When it is pressed, voltage is reduced throughout the transmitter and receiver and then using signal jacks and other instruments, it is possible to find "weak spots" in each circuit. Thus, a bad tube will show up as being in a certain circuit and the precise tube can be detected in a short time.

To protect its investment, Magnolia has enclosed its units in completely air conditioned huts to prevent equipment overheating and to control humidity. Each of the five stations has its own permanent power supply, and no standby power generators have been considered necessary.

FCC Permits

Permission to operate the microwave system is given by the Federal Communications Commission. Permits in the 2000 mc frequencies are granted on a development basis. Since Magnolia transmits and receives simultaneously, two different frequencies are required. FCC has granted the Magnolia Petroleum Company the frequencies of 1855 and 1895 mc. Between repeater stations north to south, for instance, it is sending on 1855 mc and receiving on 1895 mc. This is continued on alternate hops throughout the system, as is vertical and horizontal polarization. (See Fig. 6).

Other New Systems

It is reported that other major oil companies operating along the Gulf Coast are seeking FCC permission to install microwave equipment in the area. Doubtless, the pattern set by Magnolia Petroleum Company will be followed by many.

Acknowledgment

The author is grateful to the Magnolia Petroleum Company for permission to publish this report, and to its personnel who generously provided information and aided in preparation, and to the Radio Corporation of America for photographs and additional data used.

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Mid-South OIC Has First Meeting

Oil men and women from four states gathered for the first meeting of the newly created Mid-South district Oil Information Committee, May 23-24, at the Buena Vista Hotel in Biloxi, Mississippi.

More than 100 industry representatives from Alabama, Arkansas, Louisiana, and Mississippi attended. The Oil Information Committee is the American Petroleum Institute's volunteer public relations program.

Organization of the Mid-South district came about in January following division of the former six-state Gulf Southwest district. Texas and New Mexico, part of the Gulf-Southwest, now comprise the Southwest district.

Mid-South District Chairman W. M. Johnson, Shell Oil Company, New Orleans, said all segments of the oil industry were represented at the meeting.

Boyd Campbell, Mississippi industralist and former president of the United States Chamber of Commerce, was principal speaker at the district luncheon. Other meeting features included a "Creative Thinking" presentation by Herb Whitty, Ethyl Corporation, Tulsa, Oklahoma, and a talk, "Seach for Scientists," by Jack Naye, Shell Oil Company, New York.

District Vice Chairman W. G. Teal, Pure Oil Company, Birmingham, Alabama, presided at the meeting.

District OIC workers got their first look at 1957 Oil Progress Week plans and materials in a presentation by John F. Campbell, New York, national field director of the Oil Information Committee. Oil Progress Week is to be held this year October 13-19.

Other members of the district executive committee besides Johnson and Teal are W. B. Cotten, Jr., Esso Standard Oil Company, Baton Rouge, Louisiana, vice chairman; T. L. Carraway, Sinclair Refining Company, Jackson, Mississippi, API school program chairman; H. K. Wheeler, American Oil Company, El Dorado, Arkansas, organization chairman; C. S. Wilkins, Mid-Continent Oil & Gas Association, Baton Rouge, trade associations chairman; B. A. Hardey, Shreveport, Louisiana, and W. M. Vaughey, Vaughey & Vaughey, Jackson, advisory committee co-chairmen.

Also respective state chairmen: Alabama, J. A. Glover, The Texas Company, Birmingham; Arkansas, E. J. Gallagher, Ethyl Corporation, Little Rock; Louisiana, H. J. Geiger, Esso Standard Oil Company, New Orleans, and Mississippi, D. R. Haggart, Shell Oil Company, Jackson.

California Operators Develop

UNDERWATER DRILLING

"Depth Barrier" broken by new concept in offshore drilling — overcoming deep water, open oceans and high currents. Techniques may pose new completion methods

James A. LeVelle
Engineering Editor

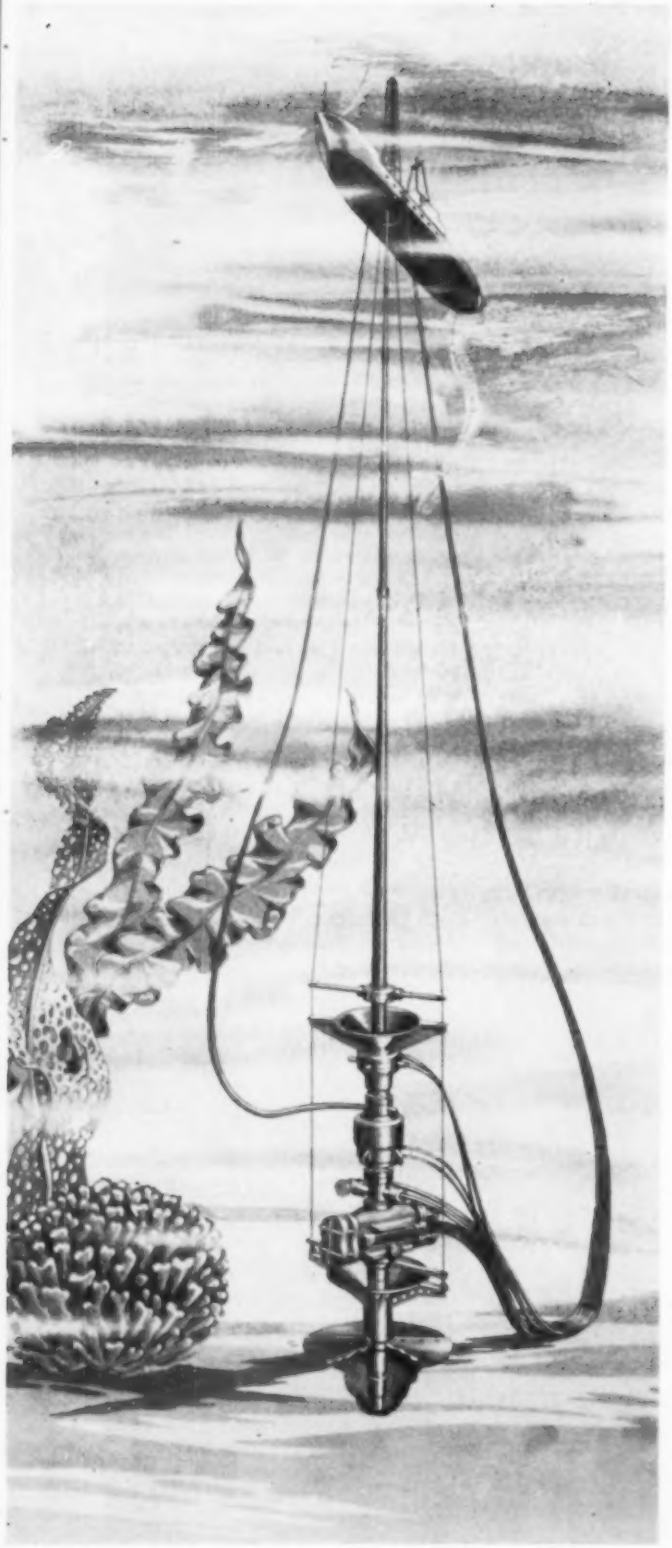

Fig. 1. **Underwater drilling** consists of drilling from a floating barge or ship through a drilling head assembly mounted on the ocean floor.

OFFSHORE California hums with the activity of core hole drilling operations in anticipation of the start of the leasing by the state. While the objective is geological data, in the background looms an even more important development. This is an underwater drilling method that is destined to permit greater economy in drilling exploratory wells and may some day bring about the development of the much discussed underwater completion of wells.

Underwater drilling is a technique in which all drilling operations (drilling, coring, cementing, etc.) are accomplished from a floating ship. Drilling heads, blowout preventers and drilling connections are mounted on the ocean floor. To date, every type of drilling, logging and cementing operation has been successfully performed using the underwater drilling method. While additional time is consumed by some of the operations, drilling rates have been comparable to land drilling operations. The apparent water location depth limit of this type of drilling is anchorability. As yet, the limit has not been encountered in California offshore operations. Core holes have been drilled to depths of 6000 ft. With the larger rigs, there is reason to believe that wells can be drilled to any depth presently reached in onshore drilling.

Presently there are nine core drilling barges operating off the shore of California. The largest of these is the "CUSS I," operated by the Union Oil Company of California, and named after the offshore group, Continental Oil Company, Union of California, Shell Oil Company, and the Superior Oil Company. This core drilling rig is mounted on a YFNB barge and is reportedly capable of drilling to depths up to 12,000 ft with 3½-in. drill pipe. The "CUSS I" is 265 ft long, has a 48 ft beam with a 9 ft draft, and is equipped with a special 98 ft derrick mounted over a center well.

Three other large core drilling rigs mounted on LSM

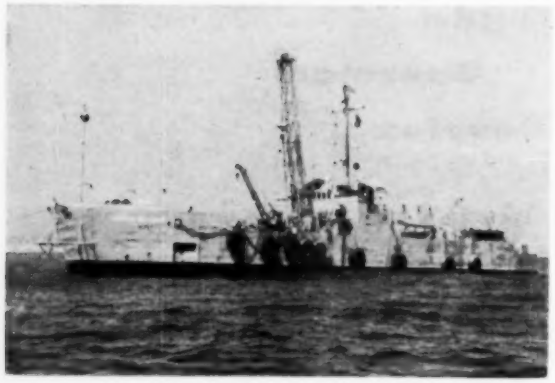

Fig. 2. **"Western Explorer,"** operated by Standard Oil Company of California, was one of the first big core drill ships outfitted for underwater drilling.

Fig. 3. **Richfield Oil Corporation's "Rincon"** is a modified LSM which is equipped with a complete geologist's laboratory and electric logging facilities.

barges are operated by Humble Oil and Refining Company, Standard Oil Company of California, and the Richfield Oil Corporation. The "Western Explorer," operated by Standard Oil Company of California, and the "Rincon," operated by the Richfield Oil Corporation, are probably the best examples of the two types of underwater drilling in use at this time.

State Controversy Blocks Development

California's offshore is just now in the process of being opened. Due to state laws, before 1955, offshore operations were prohibited except in limited cases. Where tideland leases were made available, locations were close to shore and could be readily reached by directional drilling. The Cunningham-Shell Act of 1955 opened coastal lands for leasing. Industry interest immediately increased. However, only two leases were let by the state before the state leasing program bogged down due to legislative controversy over the amount of royalty that should be paid. Coring operations and other geological evaluation is being continued by the operators on the faith that an equitable solution will soon be reached.

With the interest stimulated by passage of the Cunningham-Shell Act, California operators were faced with the new problem of deep water drilling, both for core evaluation and possible exploratory wells. Shallow water methods used in the Gulf Coast areas, while well developed, offered only limited application in the deeper California coastal waters. Open ocean, high tides, and currents further limited the use of the fixed barge type of drilling program.

In general, the ocean floor along the coast of California falls off rapidly with the result that depths of 300 to 600 ft are common within three miles of shore. In some cases, depths up to 1200 ft have been encountered. In the shallower depths (less than 300 ft), the bottom is generally described as rocky and lightly covered with sand and silt. (Where the depth exceeds 300 ft, the ocean floor is covered by a considerable thickness of silt that is generally better compacted than that found in the Louisiana Gulf Coast area.) High velocity undersea currents add to the problem of scouring and tides are larger than in the Gulf area. Locations are, in most cases, in open ocean with little protection from heavy running seas.

With this appraisal of California coast conditions, it was readily apparent that new offshore techniques would be required to economically obtain geological data and ultimately search out productive horizons. Leaving the concept of a fixed drilling platform, such as provided by mobile barges, California operators broached the idea of conducting drilling operations from the deck of an anchored ship. The unstable drilling rig floor presented several unique problems: (1) How to drill from a continuously rolling and oscillating platform and, (2), where to place the drilling assembly. In essence, the problem of the drilling assembly has been solved by placing this equipment on the ocean floor. The problem of the mobile derrick floor is solved by various techniques that compensate for the ship's motion.

Fundamental components that make up the underwater technique consist of:

1. Devices or methods which compensate for movement of the ship.

2. A method of guiding tools and drillstem to the fixed drilling assembly.

Fig. 4. **Big new "CUSS I"** has recently been put into operation by Union Oil Company of California and is reported capable of core drilling to depth in excess of 12,000 ft.

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3. The placement of the sub-sea assembly on the ocean floor and its design for drilling operations.

Underwater Drilling Method

While methods used by the various operators differ to some extent, the general procedure is roughly the same.

Towed to location, the core drilling barge is anchored, using four anchors that are, in some cases, equipped with spring anchor buoys. Prepared for drilling, a drill string, consisting of a core bit with drillable core wipes, two or more joints of 5½ to 9⅝-in. surface casing, a depth control or foundation plate assembly, special right-hand torque releasing safety joint and necessary drill pipe is run. This casing assembly is drilled in until the foundation plate is flush with the ocean floor and the string is cemented, using conventional land type cementing procedures. (See Fig. 5.) Some operators do not use the drill casing technique but, instead, drill the initial hole through a weighted ring equipped with guide cables. Surface casing is then set through the ring, using conventional cementing procedures.

After cement has set, a weighted guide head and cable support assembly is run down the drill pipe and latched to the top of the surface casing string. These cables are held in constant tension and act as the guide between the hole and the drill ship for ease in running tools in and out of the hole.

The drill string is released from the surface casing assembly and removed from the hole. The drilling assembly, consisting of blowout preventers, drilling spools, and submarine drilling head, is then run and latched into the guide and cable support assembly. Blowout preventer and drill head units are operated hydraulically from the surface. Small control lines are clamped to a mud fill-up hose which, in turn is connected between the two blowout preventers. Mud circulation returns to the ship through a separate hose that is connected below the drilling head. The submarine drilling head is similar to a reverse circulation drilling head and performs the dual purpose of preventing mud loss and also to exclude the entry of salt water into the mud system.

In drilling through the surface string and performing subsequent drilling operations, the bit is guided into the hole by arms sliding on the guide cables. The sealing component of the drilling head is carried in on the drill string and is removed when the drill string is removed from the hole. Drilling operations are carried out in a normal manner. Logging, cementing, and other down-hole operations are comparable to that of conventional drilling, with the exception that all tools are guided into the hole with the simple cable guide arrangement.

If desired at any time in the operations, the complete underwater assembly can be recovered. In core drilling, holes are being plugged and abandoned in the conventional manner and all components of the underwater assembly recovered. The only equipment left on the location is the surface casing, foundation plate and lower part of the releasing safety joint.

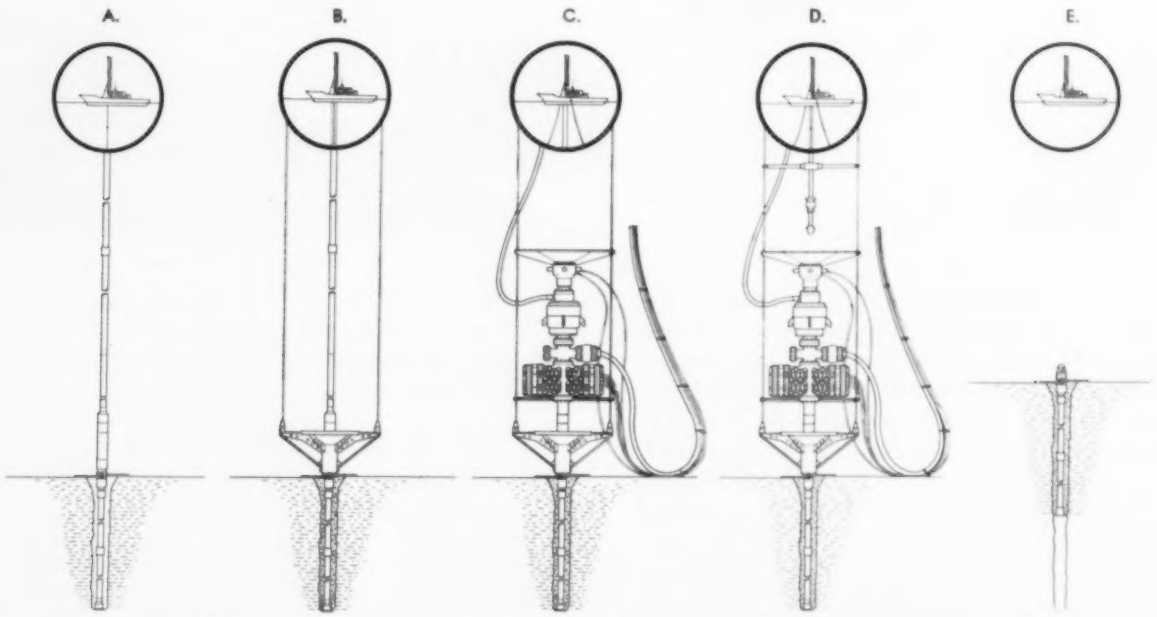
Basic Tools Operate By Surface Controls

Basic tools which make possible the underwater drilling method are the right-hand torque releasing safety joint, hydraulically operated submersible type blowout preventers and the submarine type drilling head.

The releasing safety joint in use is basically a large safety joint which can be released only through the use of a special releasing tool. The safety joint has three helical keys cut in the mandrel and barrel which engage. On mating of the helical sections, a sleeve drops into place to lock the barrel and mandrel in position. Joint is released by dropping a releasing rod or go-devil, which seats in a recess in the bumper sub immediately above the safety joint and releases the joint when an upward strain is taken on the assembly.

The tool does not require rotation to latch or unlatch and thus can be used on all components in the drilling head assembly. Basic purpose is to permit the setting of drilling equipment and its removal.

The blowout preventers used consist of double ram type preventers and



a. Surface string assembly is drilled in.
b. String is cemented and the weighted guide assembly run.
c. Drill string is disconnected and the drilling head assembly run and locked in place.
d. Bit is guided into drilling assembly and hole drilled out of surface pipe.
e. On completion of operations, plugs can be set and all drilling equipment removed.

Fig. 5. **Schematic diagram** of procedure used in underwater drilling. While several methods are being used this presentation outlines the basic steps used by all.

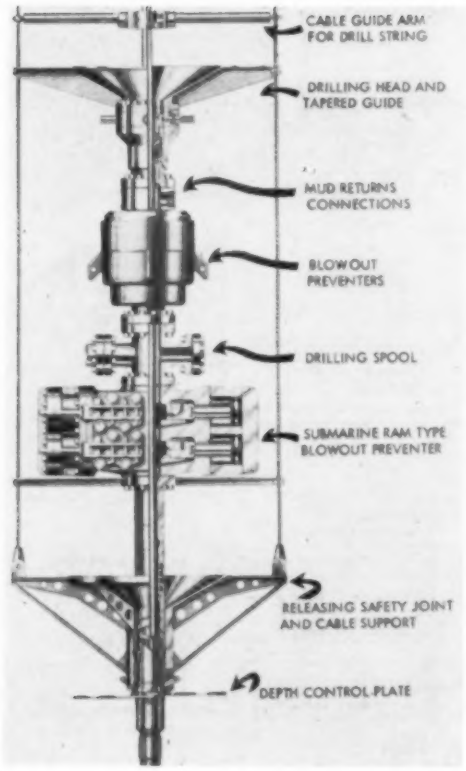

CABLE GUIDE ARM FOR DRILL STRING
DRILLING HEAD AND TAPERED GUIDE
MUD RETURNS CONNECTIONS
BLOWOUT PREVENTERS
DRILLING SPOOL
SUBMARINE RAM TYPE BLOWOUT PREVENTER
RELEASING SAFETY JOINT AND CABLE SUPPORT
DEPTH CONTROL PLATE

Fig. 6. **Typical drilling head assembly** consists of (from top to bottom) the drilling head, bag or stripper type blowout preventer, fill-up connections, ram type blowout preventers, and safety joint and guide assembly.

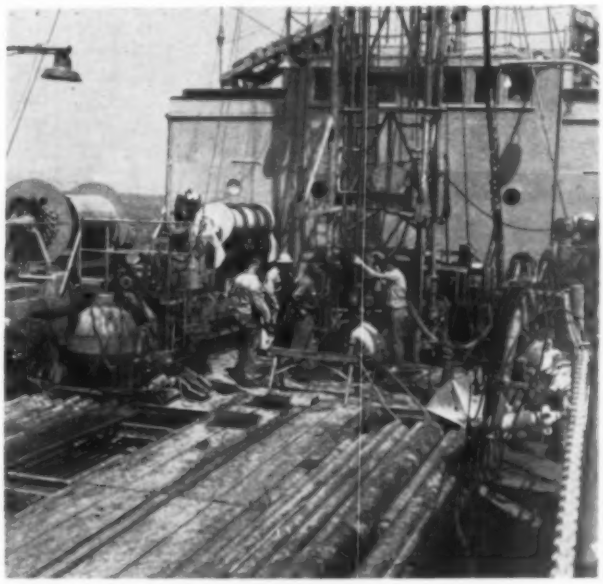


Fig. 7. **Pulling drill tubing** aboard the "Western Explorer." Tool just passing through the rotary table is the packing bushing which has been removed on the drill string from the submarine drilling head.

one bag or stripper type preventer. These units are hydraulically operated and are modified to meet subsea conditions. Units are completely sealed against well pressures, as well as from the entry of sea water. The ram type blowout preventer is used for two purposes in underwater drilling operations; one, to seal off around the drill string as in conventional installations and, two, to close off the open hole when the drill pipe is removed.

Several types of submarine drilling heads are used by operators and include the use of special stripper assemblies or an adaptation of the bag type blowout preventer. The special drilling head is similar to well known reverse circulating heads, except that the stripper rubber holding lugs are hydraulically operated and that the stripper head is designed to exclude salt water as well as seal off mud in the annulus. The head is equipped with a tapered bit guide and runners which are connected to the guide cables.

In operation the stripper rubber is carried in on the drill bit and, upon entering the head, is locked by four hydraulically operated lugs. When the drill string is to be removed, the bit is raised to a position above the ram type blowout preventer. The blind rams are closed. Locking lugs are released from the driller's position and the stripper rubber removed on the bit ring. When going in, this procedure is reversed.

Two Basic Methods Are Being Applied

At this time, two basic forms of the above system are in use and are best illustrated by the operations of the "Western Explorer," operated by Standard Oil Company of California, and the Richfield Oil Corporation's "Rincon." Both barges are converted LSM's and are outfitted in somewhat the same way. The main differences are in the method used to compensate for ship movement and in the technique of applying the drilling assembly.

"Western Explorer"

The "Western Explorer," now core drilling in the Goleta area, is equipped with a four leg box type mast and is capable of drilling to 6000 ft with 3½-in. drill tubing. The mast is mounted forward of the bridge over a 10 ft diam well in the center of the vessel. Pipe racks are mounted on the main decks and are in the forward section. Mud pits and mud handling equipment is mounted aft. Rotary table is mounted on trunions to absorb some of the ship's motion, and guides are provided on the traveling blocks to reduce sway to a minimum.

The rig is operated with a four man crew and drill tubing is laid down and picked up in running and pulling the drill string. The drill string in use is made up of 2½-in. drill tubing, 4¾-in. drill collars and two or three special 24-in. stroke bumper subs. These bumper subs are used to compensate for ship motion and permit drilling with constant weight on the bit, with the vessel heaving up to six feet. Due to the constant vertical movement imposed on the subs, special seals and rugged construction has been required. Weight set on the bit is determined by use of drill collars and the position of the bumper subs in the string. The size hole being drilled is 6⅛ in. In the near future, a 3½-in. drill tubing string will be used to provide better drilling hydraulics and improved coring operations. A considerable portion of the drilling time is spent in wireline coring.

The "Western Explorer" is not self-propelled, and is towed to location. When on location, it is held in position by four anchor lines set at 45 deg angles to the ship's center line. Conventional stockless anchors are in use. Hydraulic control lines and kill line go overboard on the starboard side of the ship, and two 2½-in. ID mud return hoses are mounted on the portside. Guide cables pass through the center drill well in the vessel and are main-

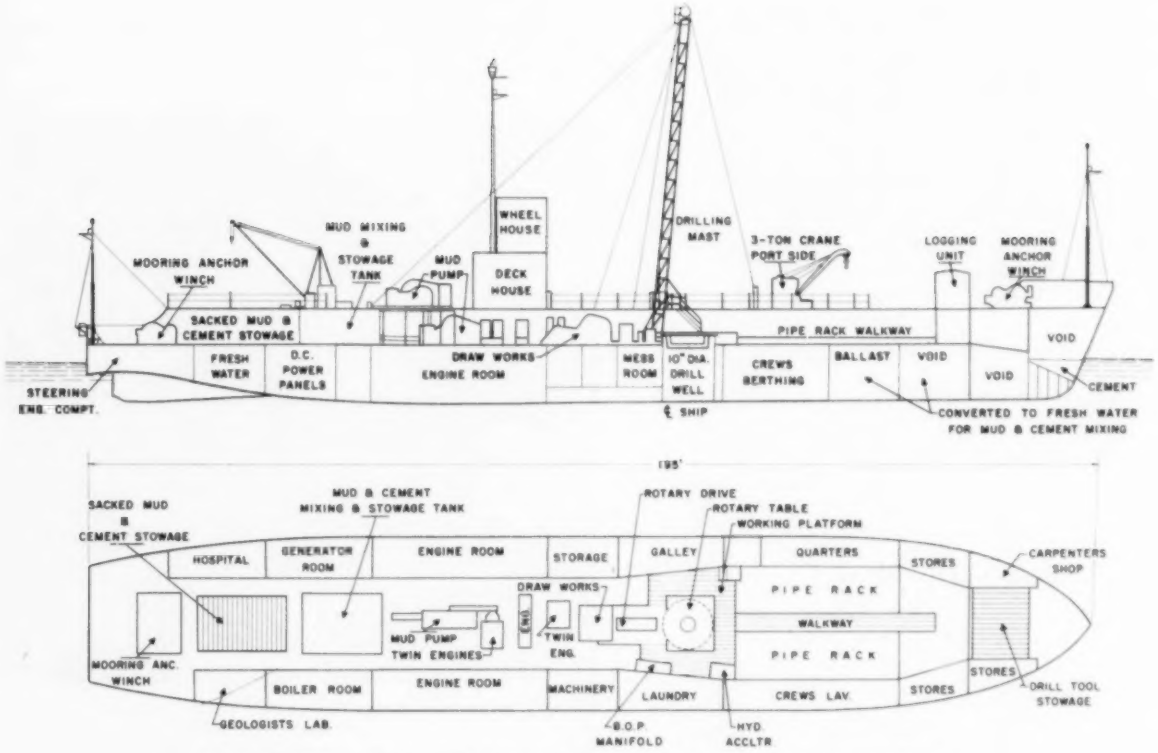


Fig. 8. **The "Rincon"** was modified to core drilling, using an LSM hull. Layout of equipment is designed for most efficient coring operations.

tained taut by an air driven drum. Tension is regulated by the air pressure, which automatically compensates for the up and down motion of the vessel.

A complete Schlumberger instrument shack and logging reel unit is built into the bow of the vessel. Cores are studied on board before removal to laboratories.

The sub sea drilling assembly used on the "Western Explorer" is basically that shown in Fig. 6.

In operation, unit has drilled successfully in water over 250 ft deep and has drilled ahead with the ship rolling up to 15 deg. In one storm, operations were shut down, and rolls of 30 deg were encountered; however, anchors held and guide lines were not detached.

It was pointed out that if storms were severe, to the extent that the anchors might drag, a plug could be set in the casing, the blind rams closed, and the guide lines and control hoses set off on buoys. At the end of the storm, these lines could be picked up, reconnected, and drilling resumed. Due to storm warnings, the ship has been prepared for such, but to date it has not proved necessary to cast lines overboard.

The "Rincon"

The "Rincon," now operated in the Gaviota area by the Richfield Oil Corporation, utilizes a 229 net ton LSM, having an overall length of 192 ft, and a 34 ft beam. It is equipped with a box type drilling mast, capable of racking drill tubing in singles, mounted in front of the bridge over a ten foot diameter drilling well. The rig is capable of drilling and coring to 6000 ft, with 3½-in. drill tubing, and has been operating in 300 ft of water. The barge has been used in coring operations to a depth of 6000 ft. Size core holes being drilled are 6⅛ and 7⅝-in. in diam.

Logging and geological evaluation equipment mounted on board includes a small, but complete, geologist's laboratory and electric logging cab and skid mounted winch installation on the forward super-structure deck.

In mooring the ship over the location, every effort has been made to stabilize the roll and pitch. The vessel uses four spring buoys which are anchored 90 deg apart. The rotary table is shaft driven and mounted on trunions to reduce the effect of ship roll on the kelly joint. The largest magnitude of motion is generally the rise and fall due to sea swells. The drilling rig is operated by a five man crew. The mud return hose reel is mounted at the stern on the starboard side near the mud pits and shale shaker. Blowout preventer and equipment control hose drum is mounted at the right of the driller's position. The guide cable reel is located on the portside and is designed to maintain constant tension on the two guide cables running to the underwater control head.

In practice, it has been found that the maximum swell in which operation can be continued is where the ship heaves 6 ft or more. This is a heavy running sea and does not result in shut down of drilling operations except in storm or near storm conditions. A weather forecast service is employed to provide predictions of expected wind velocity, wave and swell magnitudes.

The drawworks is equipped with a torque converter and the characteristics of this device are used to compensate for motion of the ship during drilling. If the drill string were held at one position in the mast, as in conventional drilling, the weight on bit would vary from zero to some high value and result in considerable pounding. To compensate for this motion, and maintain the desired weight on bit, the engine is set so that the torque converter is stalled at the desired weight on the traveling block. As the ship comes up, the traveling block comes down, or relative to

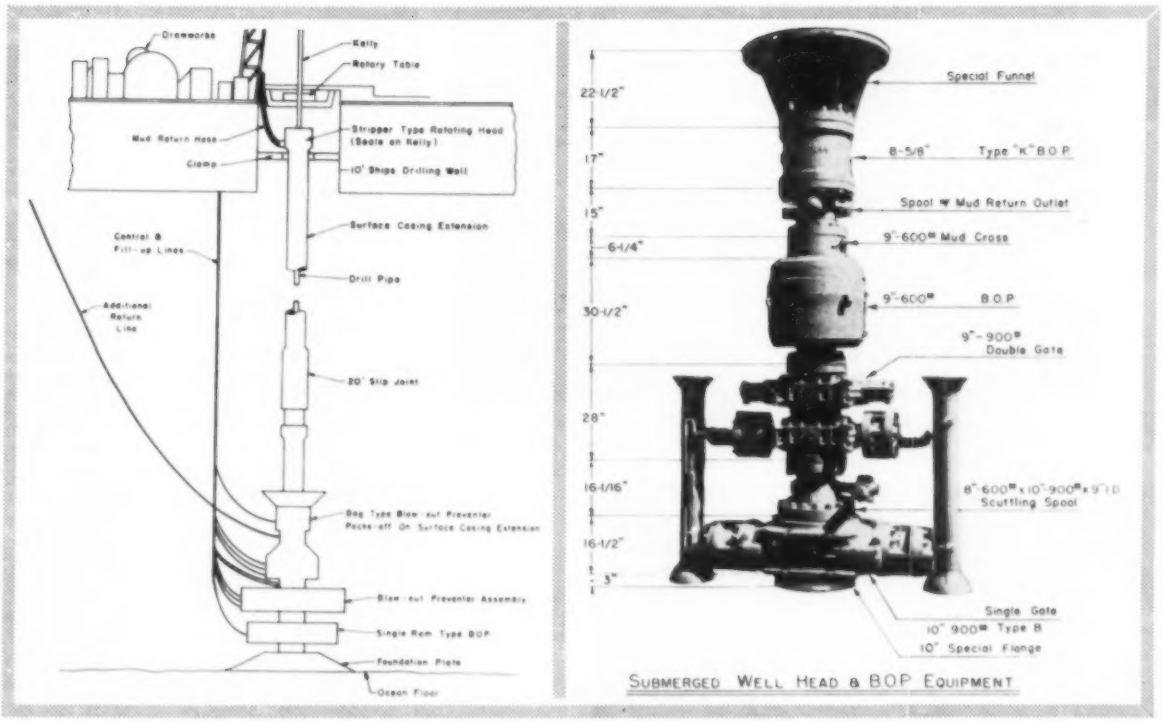


Fig. 9. **Drilling assembly** designed for future extension of drill casing into vessel's drilling well. The design may become the technique used in future ships where the rig floor will be elevated above the mud pit level.

the earth, maintains a fixed position.

Among other interesting features incorporated in the "Rincon" operation, is the underwater television, which is used with the aid of a diver to check the underwater installation. This is used periodically in routine inspections and, in some cases, when special tools are being run. Special equipment to facilitate these operations, such as TV camera davit, winch for operation of device, are built into the deck for permanent use.

Underwater Assembly

The underwater core drill assembly used by Richfield at this time is somewhat different from that shown in Fig. 6, in that a bag type blowout preventer is used instead of the submarine drilling head, and an inverted blowout preventer is used to latch on to the surface casing in place of a releasing safety joint. This is in preparation for another type of drilling assembly that is being developed by the company at this time. The assembly in use and the ultimate design that will be put into practice is shown schematically in Fig. 9.

The ultimate plan of the company is to utilize a surface casing extension into the ship well which would be equipped with a 20 ft slip joint to compensate for the vessel's motion. The drilling assembly would be approximately the same as in use at this time and consists of three ram type blowout preventers, a hydraulically actuated stripper type blowout preventer, and a bag type preventer used to seal the bottom of the surface casing extension or conductor tube. The bottom mud return line would be retained to provide additional safety in operation. The extension casing would be equipped with a rotating head which would seal off around the kelly. The extension would be clamped immediately below the rotary table within the ship's drilling well.

The obvious advantage of such an arrangement is that the drilling head would be subjected to lower operating pressures, there would be less danger of salt water contamination when withdrawing the drill string and that those components subjected to greatest wear and use would be accessible for inspection and maintenance. Application of the extension awaits the improved design and construction of drilling head equipment and outfitting of the rig with a longer kelly.

The method in which the drill head unit is used at this time is modified to the extent that a stripper rubber type bushing is run on the drill string. This fits into the top of the bag type preventer that is inflated to hold the bushing in position and pack off around it. It is used in the same manner as the special control head previously described. When the drill pipe is removed, this bushing is recovered above the bit.

Next Step Is Underwater Exploration

The application of underwater methods in California core drilling operations must be considered the forerunner to exploration well drilling techniques that will be used in the future in California, as well as other areas where deep water is encountered. Performance to date indicates that all types of drilling and other well operations can be successfully applied. The elimination of platforms or other costly structures, ability to recover equipment, and drilling depths in which operations can be performed, makes the technique most desirable where water depths exceed 100 ft or more.

In essence, the technique consists of drilling a well from a constantly moving platform. At least two successful ways have been developed to compensate for this motion.

It involves guiding tools into the hole. The two cable method appears most adequate for this operation, and may be supplemented by the cable extension method.

Fig. 10. **Underwater television camera** and floodlight is lowered over the side to inspect sub-sea equipment. Inspections are made by Richfield in conjunction with divers.

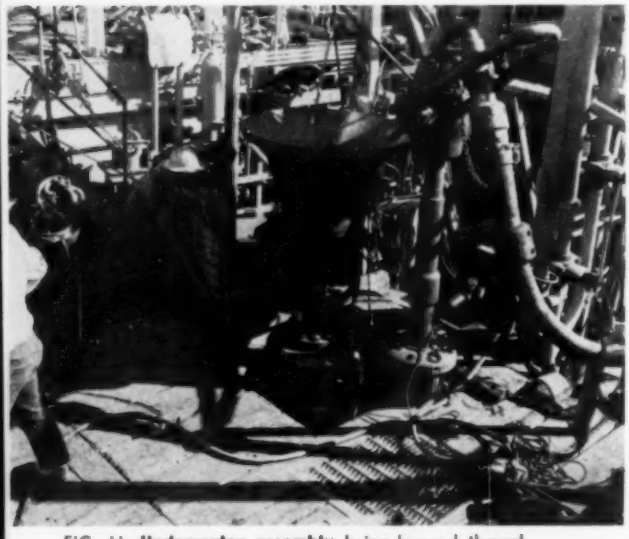


FIG. 11. **Underwater assembly** being lowered through the rotary table. It is guided into position by cables.

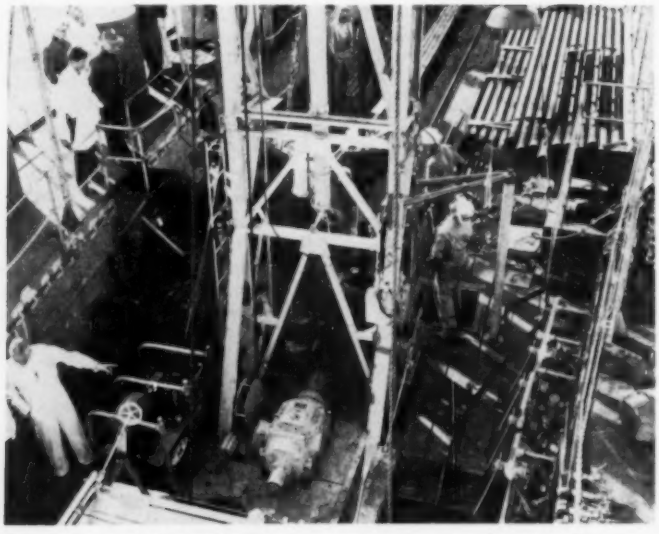


Fig. 12. **Rotary table** is mounted on trunions to reduce the effect of the ship's roll on the kelly.

The problem of adequate well control appears to be successfully handled by the underwater drilling units which incorporate blowout preventers, drill heads, blow-off lines, and controls adapted to remote operations and undersea conditions.

There seems to be little doubt that additional tools, equipment, and methods can be readily adapted to perform all needed drilling, casing, running, cementing, and other well operations.

How Will Wells Be Completed?

The subject of completing wells is much discussed by the California offshore companies, but no plans are being revealed at this time. Wells drilled by the technique could be extended above the surface to platforms, or possibly techniques will be developed to permit the completion of wells under water. In either case, underwater methods are a natural for exploratory wells.

If completions could be made underwater, considerable savings might result in development drilling through the reduction or elimination of platforms. However, it has been pointed out that a number of problems will have to be solved.

1. Marine life encrustations on wellhead equipment would cause serious difficulty in performing workovers on the well.

2. While flowing wells would, in most cases, present no serious problem, routine inspection would be desirable to assure that equipment was in good condition.

3. The problem of artificial lift looms large when regarding underwater completions, particularly in California where most wells are completed on pump and where, in many areas, crude is heavy and viscous. Many ideas, varying from shore based hydraulic pump installations to ocean floor pumping units has been expounded; however, no simple solution exists at this time.

These are but a few of the problems under consideration at this time. There is every possibility that they will be solved. There is every reason to believe that the underwater core drilling method developed in offshore California today is the forerunner of underwater completions in the deep waters of California, the Gulf Coast, and other offshore areas.

Acknowledgment

The author gratefully acknowledges the help and guidance provided by the Standard Oil Company of California, the Richfield Oil Corporation, and Shaffer Tool Works, Inc., and their employees, in making this report possible.

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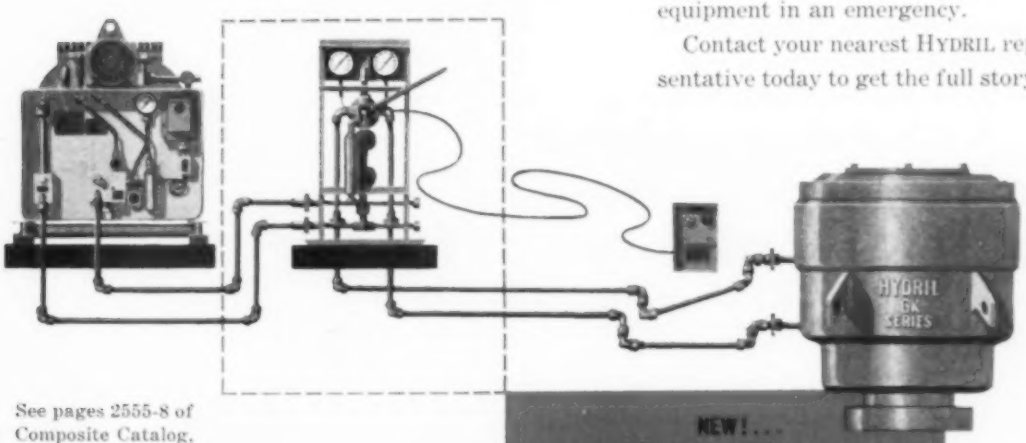

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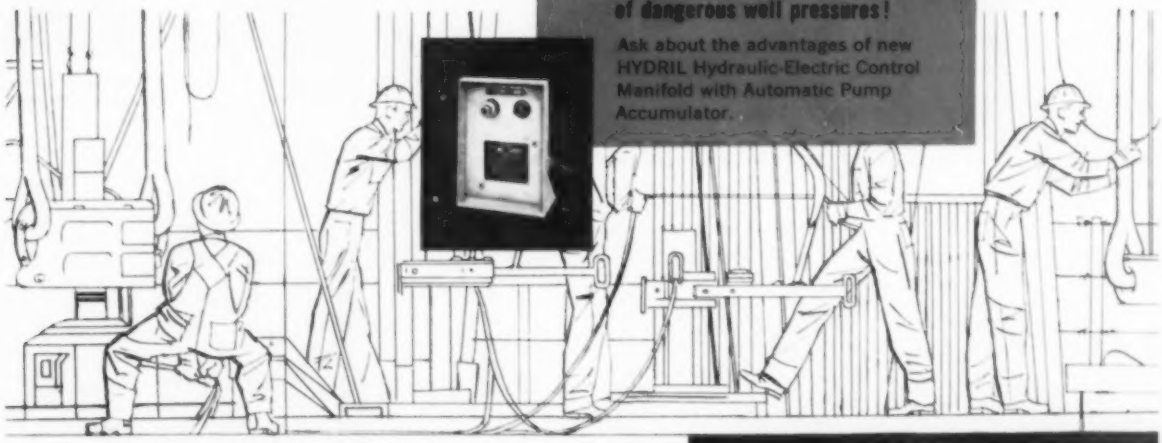

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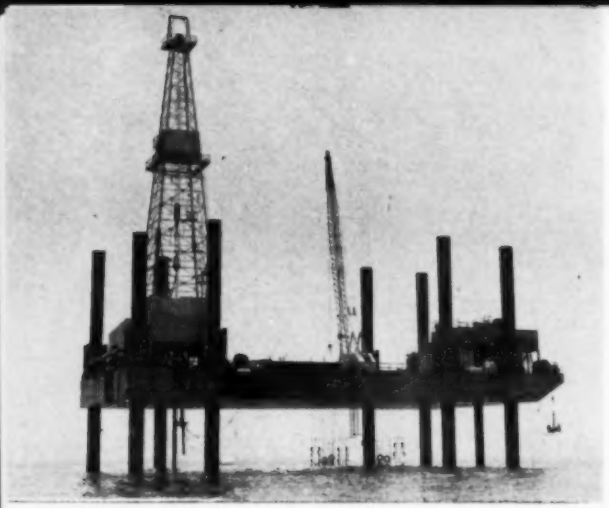


The Pacific Driller No. 1 drilling in 80-ft of water off the coast of Santa Barbara, California near the Summerland field. Personnel transfer from boats by means of rope ladders hanging over the side.

Pacific Driller No. 1

California's Lone Mobile Drilling Barge

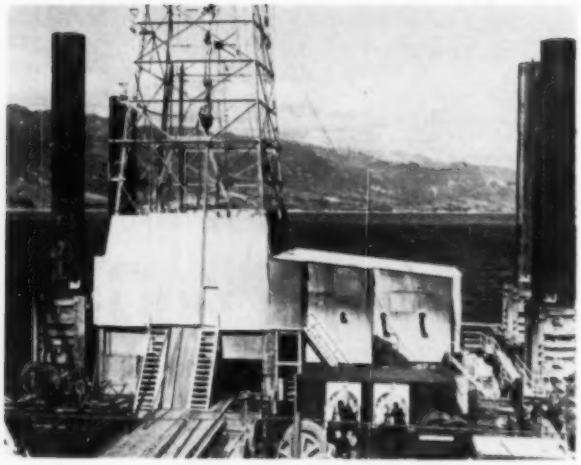
The Pacific Driller No. 1, the first and only mobile drilling barge operating in the California offshore waters, is currently engaged in core drilling work off the coast of Santa Barbara County near the Summerland field. This is the most active offshore area on the West Coast today. The new unit is owned and operated by Offshore Constructors, Inc. of San Francisco. Equipped with a complete drilling rig capable of drilling and completing wells to maximum depths encountered in California, the new mobile unit will be used for exploration operations when offshore areas are opened up again.

The platform-hull weighs 4000 tons (more than the total weight of two U. S. Navy destroyers) and is of the DeLong type. It measures 200 ft long, 100 ft wide, and 13 ft deep. The hull is supported at the offshore drill site by eight caissons 195 ft long by 6 ft in diameter, each equipped with two 300-ton capacity DeLong air jacks. Unit can be moved and ready for drilling at a new site within 24 hours. Drilling capacity is in excess of 15,000 ft with 3½-in. drill pipe.

The new mobile unit has been operating in 80 ft of water and no difficulty has been reported in obtaining adequate footing on California offshore locations. One innovation in the operation of the unit is the use of a tractor tread-mounted, self-propelled crane on the barge deck. It is used to load and unload drill pipe as well as perform other lifting operations on the structure. Mobility of this crane has enabled the drilling crews to perform many functions which would be impossible with fixed cranes.

The Pacific Driller No. 1 is currently core drilling for Standard Oil Company of California and Humble Oil & Refining Company. She was fabricated in New Orleans, Louisiana, towed through the Panama Canal and outfitted at Terminal Island, all within the record time of six months.

Offshore Constructors, Inc., is the outgrowth of a joint venture originally formed by its affiliates, Bechtel Corporation, DeLong Corporation, Healy Tibbitts Construction Company, and Raymond Concrete Pile Company. It is operated by Offshore Constructors, in cooperation with Sun Marine Drilling Company, an affiliate of San Joaquin Drilling Company.



Derrick floor and engines have been enclosed for protection against prevailing cold winds. Note 6-ft caisson legs, each 195 ft long and equipped with two 300-ton DeLong air jacks.

Self-propelled crane is used on deck of Pacific Driller No. 1 to hoist equipment and materials aboard and to perform endless lifting jobs.

Business end of the Pacific Driller No. 1 is supported by four 6-ft diameter caissons. Bottom of hull is flat. Note slot on drilling end.

New full opening safety valve used in Shell's unique . . .

Well Completion Program In Lake Maracaibo

Hookup allows either tubing or casing flow, gas lift on tubing or casing, with dependable safety protection for well

D. M. Koons,
Compañia Shell de Venezuela
Maracaibo, Venezuela

COMPAÑÍA Shell de Venezuela has recently adopted a new type completion for its wells in Lake Maracaibo, involving the use of an entirely new safety valve. This completion, which required the development of several pieces of equipment besides the safety valve, is the result of several years effort to obtain a completion that would fulfill the production and operating program of Shell and particularly to provide dependable safety protection for the wells.

Wells are drilled from permanent platforms set in water depths varying between 60 and 110 ft, and completed after cementing 7-in. casing from depths of 5000 to 8000 ft. Wells are completed by perforating intervals amounting to a total of a hundred or more feet using expendable tubing guns. They are brought into production flowing at rates of 1000 bbl per day, upward.

Such a completion for these wells had to meet the following requirements:

1. Safety valve must have a positive action and not depend on trial and error settings. It must also be easily tested and reopened from the surface. These requirements are necessary because of the danger of collision with the wells by heavy round-the-clock shipping traffic of tankers, freighters, and barges. Shell already has about 150 producing wells in the lake and the number is increasing quickly. All these are being given safety protection.

2. Safety valve must not interfere with normal operations during the completion, or while the well produces. This is obvious, considering the expense of operating over water and the large number of wells.

3. The safety valve must not unduly restrict production for rates of flow up to say as much as 12,000 bbl a day (design figure) of total fluid.

4. Completion must be adaptable for permanent type completions and workovers. A completion using expendable through-tubing guns, aside from eliminating possible formation damage by mud, is considered to be a more safe method.

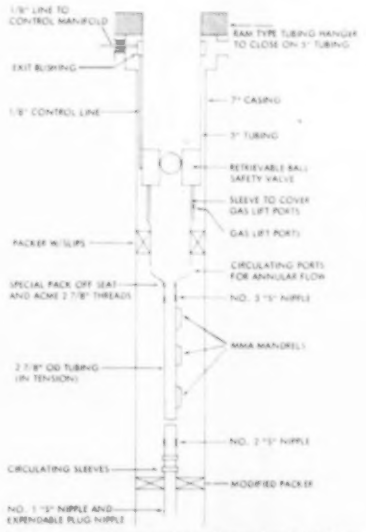
5. Completion must permit production by either tubing or annular flow. For wells with a thick producing section, and a large productivity index, annular flow is necessary to produce the wells equitably.

6. Completion must enable gas lifting on either the tubing or the annulus.

7. Completion and the equipment must be as simple and dependable as possible.

It was also concluded that in order to obtain the best protection for the well against collisions, the tubing should be hung from the casing down inside the well and not from the Christmas tree. Thus anything which might happen to the Christmas tree would not mechanically affect the down-the-hole installation.

The completion adopted (Fig. 1)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EXIT BLOWING
1/8" CONTROL LINE
PACKER W/SLIPS
SPECIAL PACK OFF SEAT AND ACME 2 7/8" THREADS
2 7/8" OD TUBING (IN TENSION)
CIRCULATING SLEEVES
NO. 1 "S" NIPPLE AND EXPENDABLE PLUG NIPPLE
RAM TYPE TUBING HANGER TO CLOSE ON 5" TUBING
7" CASING
5" TUBING
RETRIEVABLE BALL SAFETY VALVE
SLEEVE TO COVER GAS LIFT PORTS
GAS LIFT PORTS
CIRCULATING PORTS FOR ANNULAR FLOW
NO. 3 "S" NIPPLE
MMA MANDRELS
NO. 2 "S" NIPPLE
MODIFIED PACKER

FIG. 1. **Tubing-casing flow installation developed for Shell's Lake Maracaibo operations. Note that the tubing is hung from casing down inside the well and not from the Christmas tree.**

meets practically all of these requirements. Essentially it consists of a string of 2⅞-in. OD tubing in 7-in. casing. The tubing is held in tension by a modified retainer production packer at the bottom, and by a special hydraulic packer at the top of the string that is hung some 200 ft below the well head, i.e. a considerable distance below lake bottom. The tubing string also contains permanent type well completion nipples, large area circulating sleeves, and retrievable gas lift valve mandrels. Above the hydraulic packer 5-in. extreme line casing is used as tubing to the surface where it is sealed, but not hung, in the Christmas tree. A full opening ball type wireline retrievable safety valve is installed in the 5-in. tubing at a depth of about 200 ft. This safety valve is hydraulically controlled from the surface through an ⅛-in. line run in the 5 by 7-in. annulus.

The upper hydraulic packer, aside from hanging the tubing, also serves to seal the tubing/casing annulus so that production flowing up the annulus is diverted upwards through the safety valve in the 5-in. tubing string to the surface.

Ports in the 5-in. tubing below the safety valve allow for future gas lifting but are sealed off while the well flows naturally. Gas lifting is accomplished by injecting gas down the 5 by 7-in. annulus to these ports, and then by suitable cross-over tubes to either the tubing or casing annulus as desired. These tubes are lubricated in or out of the well so that it is not necessary to kill the well to make the changes for gas lifting. They also contain check valves for the injection gas as an additional safety precaution.

Production phases; flowing on tubing or casing, gas lifting, and permanent type well completion workovers, are shown diagrammatically in Fig. 2.

The essential equipment used for this completion was developed and made by Otis Engineering Corp., Dallas, Texas.

FIG. 2. **Production phases** are diagrammatically illustrated here. Shell's equipment permits permanent type well completion workovers.

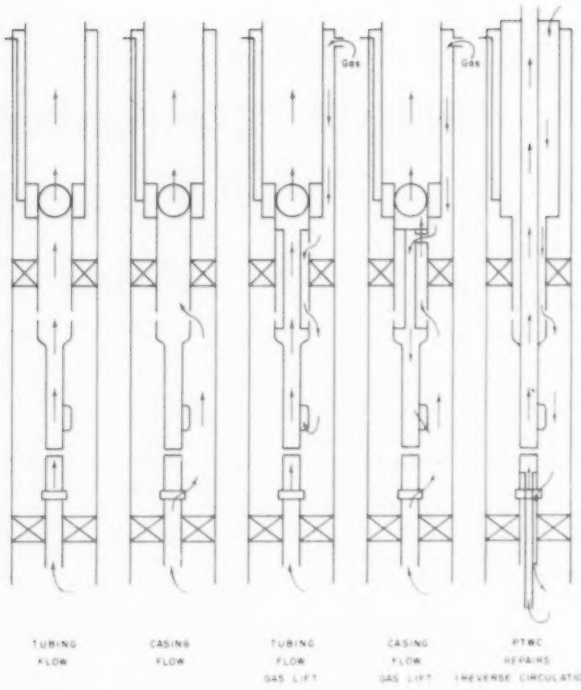
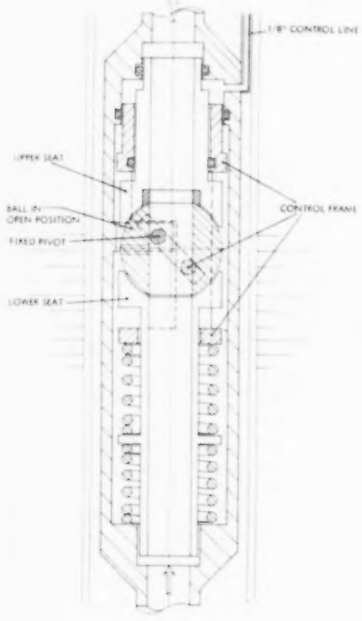


FIG. 3. **Schematic diagram** of the ball type safety valve. Similar to a plug valve, it has — instead of a tapered cylinder — for a core a ball with a hole through it.



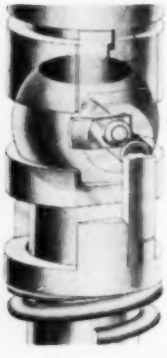
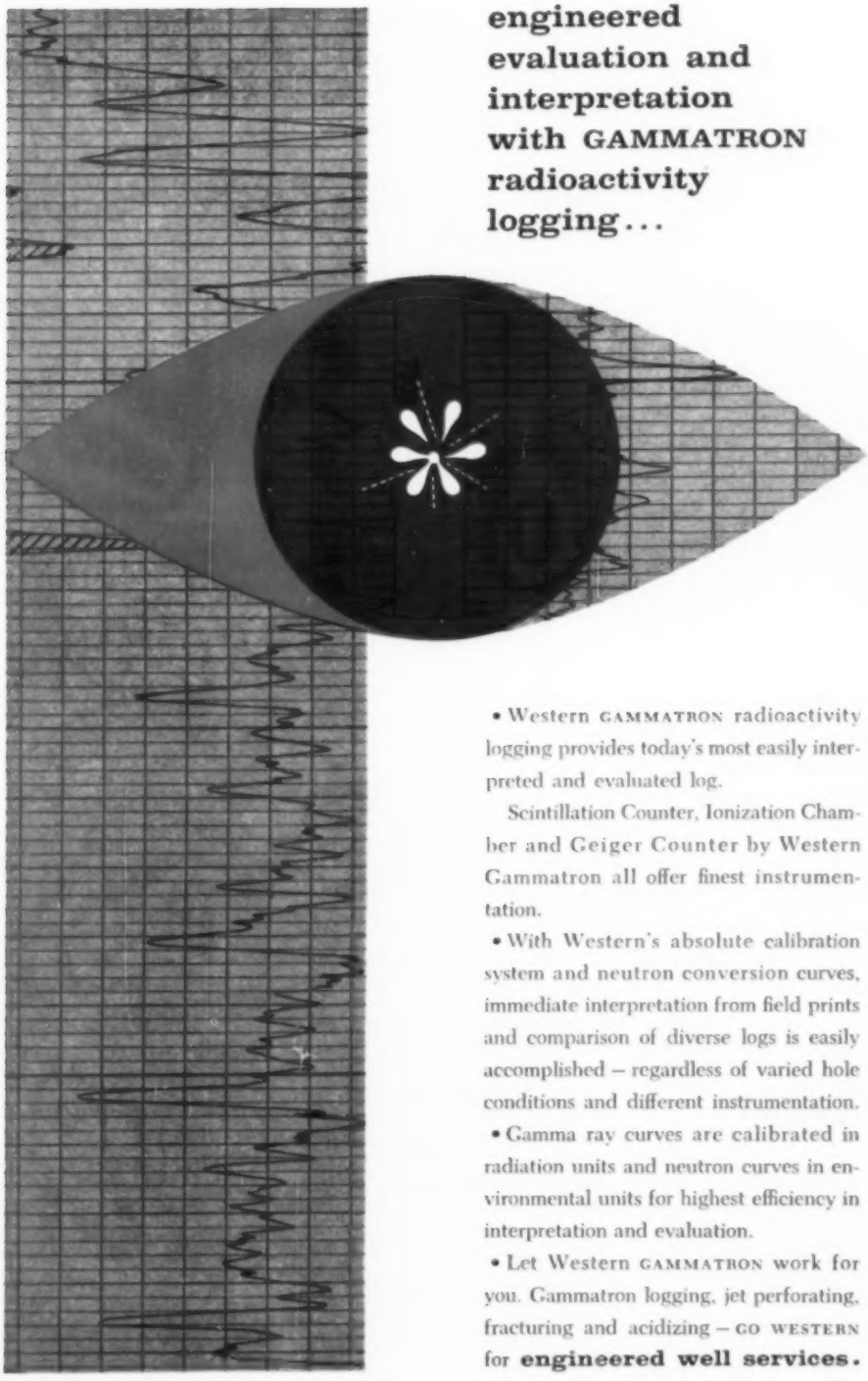


FIG. 4. **Ball type safety valve,** with close-up of ball and rotating mechanism. Large bore of the valve makes it possible to run tubing tools and instruments without first pulling the valve.

Ball Type Surface Controlled Safety Valve

This safety valve serves several purposes. Foremost is to close-in the well in case of an accident, such as a tanker or barge collision, which would damage the well so that it would flow uncontrolled. Also it is to close-in the well in case of a flow line break, frequently caused by dragging anchors. The valve also can be used to close-in the well automatically from the flow station in case of emergency, when, for instance, a separator fails to function properly or pumps stop due to electrical line failure. Because the safety valve is full opening, it also serves as a 200 ft lubricator while perforating with expendable through-tubing guns. Guns up to 100 ft long have been used.

The safety valve (Fig. 3 and 4) can best be described as being similar to an ordinary plug valve. However, for a core it has a ball with a hole through it instead of a tapered cylinder. Attached to the side of the ball is a control frame that moves the ball to the open or closed position. One end of the control frame is connected to a piston which holds the ball in the open position when hydraulic pressure is applied from the surface via a ⅛-in. line. At the lower end of the control frame are compression springs. When the hydraulic pressure is released from the piston these springs move the control frame and cause the ball to rotate to the closed position.



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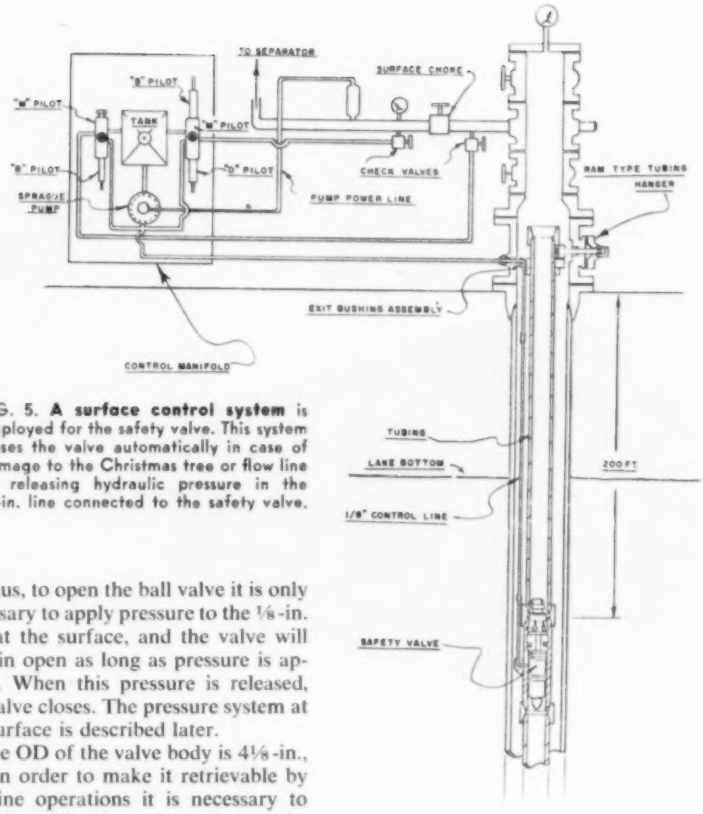


FIG. 5. **A surface control system** is employed for the safety valve. This system closes the valve automatically in case of damage to the Christmas tree or flow line by releasing hydraulic pressure in the ⅛-in. line connected to the safety valve.

Thus, to open the ball valve it is only necessary to apply pressure to the ⅛-in. line at the surface, and the valve will remain open as long as pressure is applied. When this pressure is released, the valve closes. The pressure system at the surface is described later.

The OD of the valve body is 4⅛-in., and in order to make it retrievable by wireline operations it is necessary to use 5-in. tubing from the surface to the valve's seat. Also, the vertical bore of the Christmas tree must be 4¼-in. The valve, when installed in the well, is locked in a seating nipple by lugs similar to any wireline tool.

Aside from the system used to control the valve, its main feature is that, when open, the bore of the valve is the same as 2⅞-in. tubing. Thus any tubing tool or instrument, such as expendable tubing guns, pressure bombs, swabs, tubing plugs, etc., can be run in the well without first pulling the valve.

Safety Valve's Surface Control System

Another unique feature of the safety valve is its surface control system. This system, shown diagrammatically in Fig. 5, closes the safety valve automatically in case of damage to the Christmas tree or flow line, simply by releasing the hydraulic pressure in the ⅛-in. line connected to the safety valve. It also provides a means to test the valve's closure from the surface. Essentially it is a power supply to maintain pressure in the ⅛-in. line to hold the valve open and controls to release this pressure, automatically, to close the valve. All this is contained in a small manifold installed on the well platform (Fig. 6). Small pressure lines connect the manifold to the flow line, the tree, and the ⅛-in. hydraulic line connected in the tree. Also included in the manifold is a gas operated diaphragm pump which is used to maintain hydraulic pressure in the control system. Gas to operate the pump is obtained from a riser on the flow line. The pump is also connected to a small reservoir of oil to compensate for any losses in the system.

Pressure lines from the flow line and Christmas tree are connected to "pilot" valves on the manifold. Pilot valves are set to open at predetermined pressures and when one of these opens, the pressure in the entire control system is released, causing the safety valve to close. Two pilots are used for the flow line. One opens when the flow line pressure drops below a certain pressure which would occur if the flow line broke. The other pilot opens if the flow line pressure rises above a certain predetermined pressure, which would happen if the flow line became plugged or was closed in at the flow station.

Pilot valve in the line from the Christmas tree will open if the wellhead pressure falls below a certain predetermined pressure. This would occur if a flow arm or another part of the Christmas tree should be knocked off, or if any large leak in the tree occurred.

To test the safety valve for closure it is only necessary to lower the pressure on the manifold by opening a small valve and observing the immediate wellhead pressure drop.

This surface control system has been installed on more than 100 wells in the last two years (for a different type of safety valve) and has operated very satisfactorily. To date there has only been one instance of a head-on tanker collision with a well, which resulted in the Christmas tree being knocked off below the master valve. The closed safety valve kept the well from flowing and entirely avoided what could have been a major catastrophe.

The ⅛-in. hydraulic line used to transmit the pressure from the surface controls to the safety valve consists of ⅛-in. API extra heavy wall line pipe with special slim collars. This has proved quite satisfactory over the last two years. To conduct this line through the tree, an exit bushing on the 5-in. tubing is used, as shown in Fig. 7. The ⅛-in. line is run simultaneously with the tubing. After the 2⅞-in. tubing is hung from the hydraulic packer, the exit bushing is placed on the 5-in. tubing using a jig to align the bushing with an outlet on a ram type tubing head. The ⅛-in. line is then connected to the exit bushing and the tubing head slipped over the 5-in. tubing. After the rams are closed on the tubing to seal the 5 by 7-in. annulus, a short nipple is screwed into the exit bushing through the tubing head outlet. This is packed off by a gland and the line connected to the surface control system.

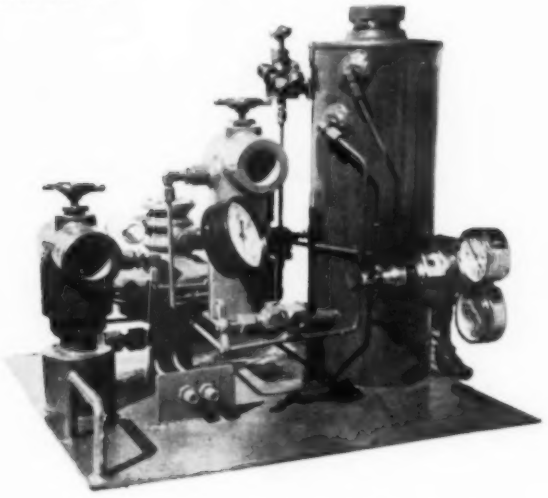
Use of rams which only seal the 5 by 7-in. annulus is a particular safety feature of the completion. In case of a collision where the tree would be knocked or pulled off, the tubing head would slip over the tubing without placing undue strain on the tubing string. If the tubing was hung from the tree there would be the chance that the tubing could be pulled in two during a collision.

Hydraulic Packer-Tubing Hanger

Key to the success in this completion was the development of a packer to hang the tubing in tension. In the completion it was essential to latch the tubing to a retainer production packer at the bottom to prevent the tubing string from moving upwards if the safety valve closed against high pressure. Tension in the tubing string is necessary to facilitate running expendable tubing guns.

The packer-tubing hanger developed, as shown in Fig. 8, is set and released hydraulically, without turning the tubing. The packer consists of a sliding sleeve over a mandrel, so arranged that two pressure tight chambers are formed between the mandrel and the sleeve. The upper end of the

FIG. 6. **Control manifold** makes it possible to open, close or test the valve. It maintains pressure in the ⅛-in. line to hold valve open. When this pressure is released, valve is closed.



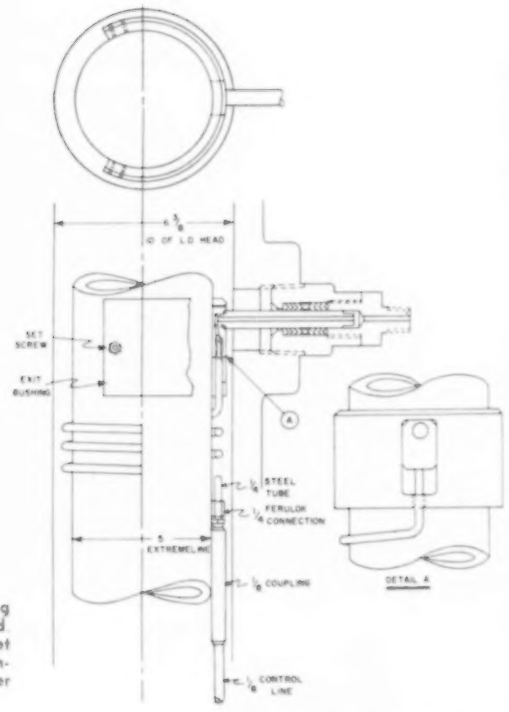


FIG. 7. **Exit valve** for use on 5-in. casing in conjunction with a ram type tubing head. The exit bushing is pre-aligned with an outlet on the tubing head, the ⅛-in. line is connected, then tubing head is slipped over the 5-in. tubing.

sleeve is connected to slips and the lower end rests against a packing element. When pressure is applied to the upper chamber alone, it causes the sleeve to move downwards pulling the slips into a retracted position.

To run the packer in a well the upper chamber is pressured with grease and is retained by a plug which protrudes into the inside bore of the packer. After the tubing is latched on to the production packer at the bottom, the protruding plug is knocked off by a sinker bar that releases the pressure in the chamber. When the desired tension is placed in the tubing string, pressure is applied to the inside of the tubing, say 200 psi. Pressure is not effective in the upper chamber because it is counteracted by the equalizing chamber below, but pressure is transmitted to the lower packing element via the circulating ports below the packer. This moves the element and sleeve upwards setting the slips. Thus the tubing string is hung from the packer 200 ft below the surface.

The packer can be released by isolating the upper chamber by a suitable tool and applying pressure in this chamber.

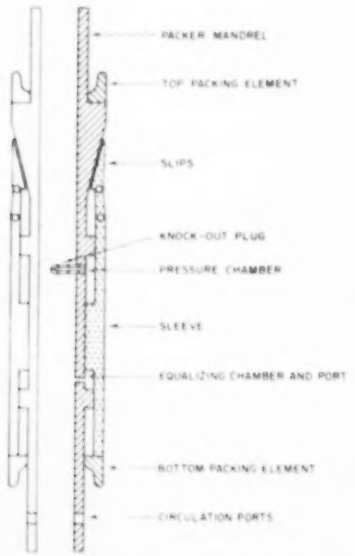


FIG. 8. **Packer-tubing hanger** is set and released hydraulically, without turning the tubing.

Special Retainer Production Packer

A standard production packer, the Baker model "DA," has been modified to include below it a type "S" nipple, and an expendable plug nipple, both for 2⅞-in. OD tubing. Thus, when a plug is placed in the "S" nipple, the well is under control and even the tubing can be pulled without killing the well.

Completion

Actual completion takes about three hours longer than normally. The tubing is run in and latched on to the retainer production packer and pressure tested. It is then unlatched and pulled up about 200 ft. and the hydraulic packer, gas lift port nipple, and safety valve assembly is added. No spacing calculations are involved in the operation. Tubing is then lowered on 5-in. tubing, running the ⅛-in. line simultaneously. After latching on again to the production packer, the ⅛-in. line is pressure tested and the protruding plug knocked out of the hydraulic packer with a sinker bar. A strain is then placed on the 5-in. tubing to obtain the desired tension in the 2⅞-in. tubing, and the 5-in. tubing is pressured to 200 psi to set the hydraulic packer. The tension in the 5-in. casing is then released and the casing cut off above the 7-in. casing head. After installing the exit bushing the tubing head is slipped over and the rams closed on the 5-in. casing. The Christmas tree is then installed and the well is ready for perforating with expendable guns.

Acknowledgment

Development of this completion is the result of the joint effort of the engineering and operating personnel of Compañía Shell de Venezuela and Otis Engineering Corp. The author wishes to express his appreciation to these two companies for their permission to publish this paper. ★ ★ ★

"All UNIONS aren't the same -- specify WECO by name"

Examine a WECO Union and you will see that all unions are not the same.

The difference is readily noted in WECO'S metal-to-metal ball and cone seat that is unequaled for positive, leak-proof sealing under the severest conditions.

The ease and speed of repeated make-up and break-out is apparent in the sturdy, accurately cut Acme threads.

The extra strength of WECO Unions is evident in the heavier wall sections that are machined and knurled for uniform wall thickness and safer wrenching . . . in the sturdy wing nut that takes heavy hammering as a matter of course.

These differences in design and construction make WECO Unions superior in sealing and economical in service. That's why it pays to specify WECO Unions by name, from supply stores everywhere.

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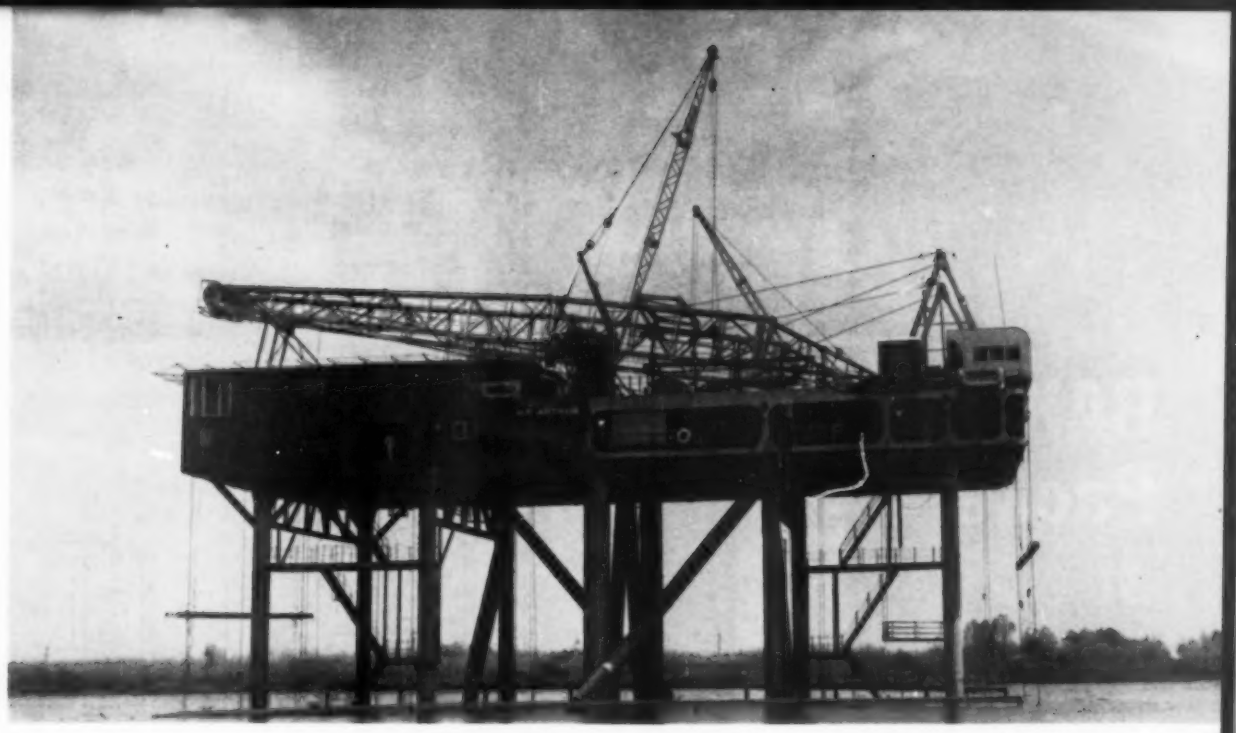


Coral Drilling Company's "Mr. Arthur" undergoing submergence tests in Mobile Bay prior to going on location in Block 45 of the Main Pass area for The California Company.

P 422.912

One of the most fully equipped and elaborate of the offshore fleet

"MR. ARTHUR"

. . . New Mobile Submersible Drilling Giant

It took over a year and nearly $5 million to design and build this sleek, powerful barge. It is among the first offshore units to be completely diesel-electric powered

Harvey B. Elder, Jr.
Coral Drilling Company, New Orleans, Louisiana

THE latest mobile giant to join the offshore search for oil is Coral Drilling Company's "Mr. Arthur," a California type, elevated deck, self-stabilizing, submergible mobile drilling unit rated for 20,000-ft depths. Slated for use in water depths up to 70 ft and built at a total cost of nearly $5 million, the new mobile unit was designed by Friede and Goldman, Inc., of New Orleans and built by Alabama Drydock and Shipbuilding Company of Mobile, Alabama. "Mr. Arthur" is among the first offshore giants whose drilling equipment is entirely diesel-electric driven and incorporates the latest in equipment and design features. The vessel was built to special classification and inspection of: (1) American Bureau of Shipping, (2) to meet U. S. Coast Guard safety regulations, and (3) has been documented and admeasured by the U. S. Bureau of Customs. The drilling and shipbuilding industries, by pooling their talent and effort, have made this an outstanding unit.

Barge Design Features

The basic hull measures 155 ft long by 90 ft wide and has a molded depth

Only the BAKER Packer does so many jobs so well !

PRODUCTION APPLICATIONS

SINGLE ZONE Normal Completion

SINGLE ZONE Permanent Type Well Completions

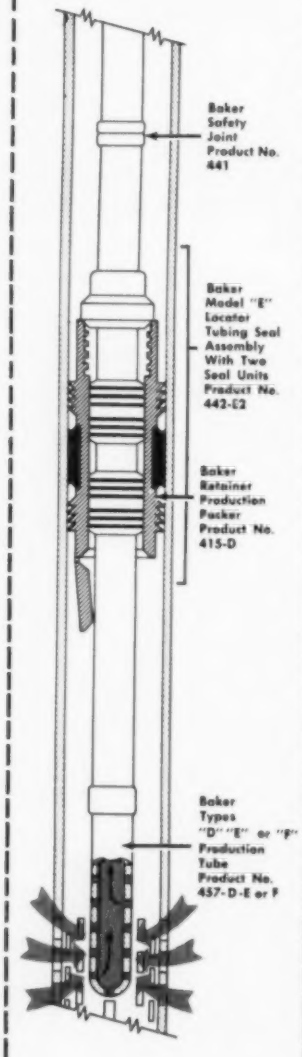
Baker Retainer Production Packer Product No. 415-D

FEATURES

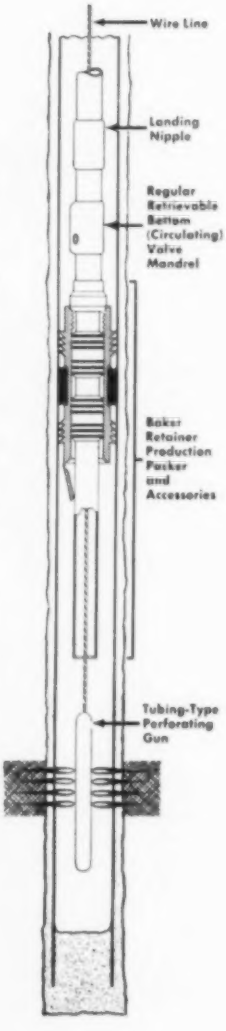
Holds any pressure from either above or below that is safe for the casing, even under temperatures in excess of 300°F.

Pack-off is independent of set-down weight or tension. Tubing string is free; just pick up (or unlatch and pick up) to remove it.

Use it as a squeeze and testing tool or as a temporary or permanent bridge plug in conjunction with any production application.


Baker Safety Joint Product No. 441
Baker Model "E" Locator Tubing Seal Assembly With Two Seal Units Product No. 442-E2
Baker Retainer Production Packer Product No. 415-D
Baker Types "D" "E" or "F" Production Tube Product No. 457-D-E or F

Illustrates Packer set in casing with Locator Tubing Seal Assembly and Production Tube installed for single-zone production.



Illustrates typical Permanent-Type Well Completion Hook-Up showing perforating operation through and below the Packer.

BAKER OIL TOOLS, INC.

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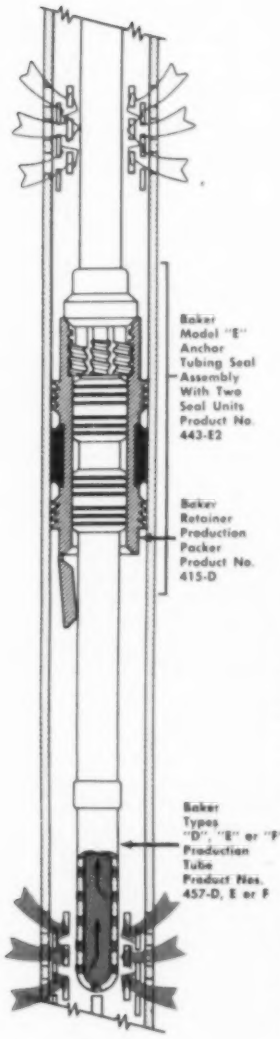
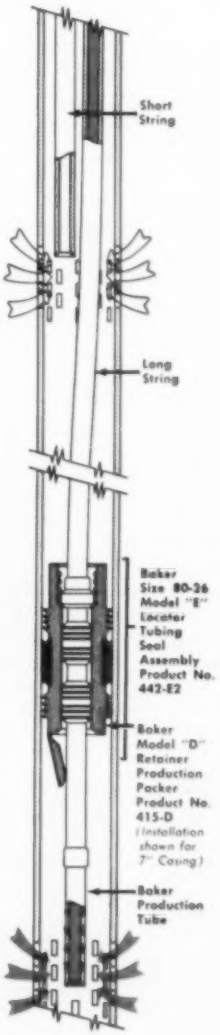
BAKER

DUAL ZONE
Normal Completion


Baker Model "E" Anchor Tubing Seal Assembly With Two Seal Units Product No. 443-E2
Baker Retainer Production Packer Product No. 415-D
Baker Types "D", "E" or "F" Production Tube Product Nos. 457-D, E or F

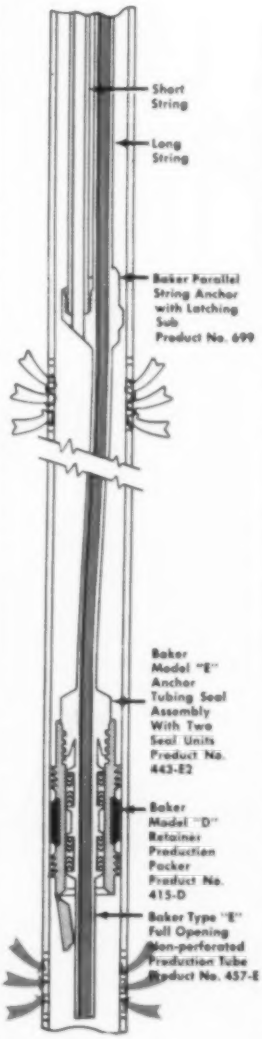
Illustrates Packer set in casing, with anchored production string for dual-zone production. Tubing can be released from Packer by rotating to right.

DUAL ZONE
Parallel String
Short String
Hanging Free


Short String
Long String
Baker Size 80-26 Model "E" Locator Tubing Seal Assembly Product No. 442-E2
Baker Model "D" Retainer Production Packer Product No. 415-D (Installation shown for 7" Casing)
Baker Production Tube

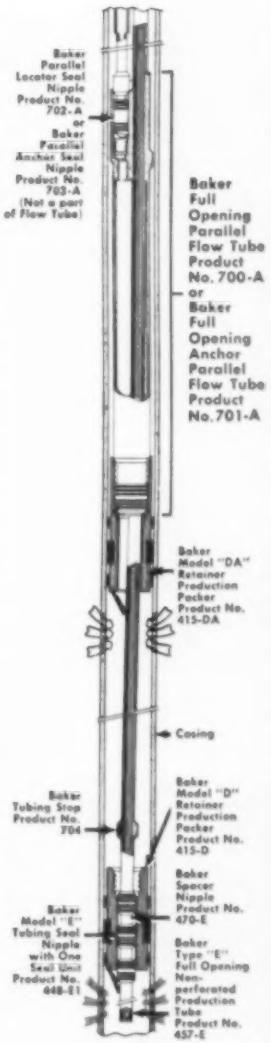
Permits removal of either string independently of the other regardless of sequence. Full-Opening (Tubing I.D.) Long String to lower zone.

DUAL ZONE
Parallel String
Short String
Anchored

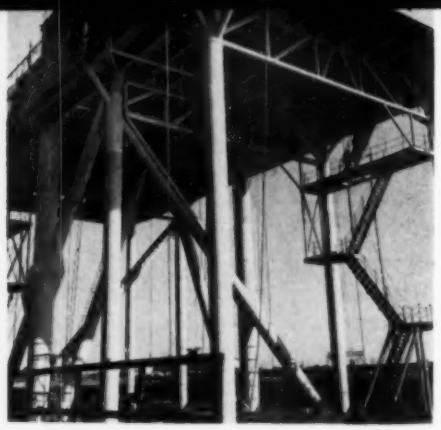

Short String
Long String
Baker Parallel String Anchor with Latching Sub Product No. 699
Baker Model "E" Anchor Tubing Seal Assembly With Two Seal Units Product No. 443-E2
Baker Model "D" Retainer Production Packer Product No. 415-D
Baker Type "E" Full Opening Non-perforated Production Tube Product No. 457-E

Permits removal of either string independently of the other, however long string must be run first. Short string pulled first. Full-Opening (Tubing I.D.) Long String.

DUAL ZONE
Parallel String
Two-Packer Hook-up

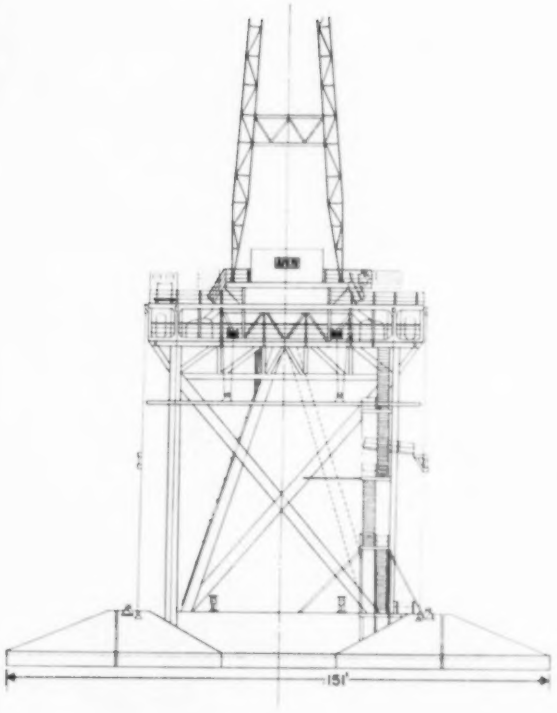

Baker Parallel Locator Seal Nipple Product No. 702-A or Baker Parallel Anchor Seal Nipple Product No. 703-A (Not a part of Flow Tube)
Baker Full Opening Parallel Flow Tube Product No. 700-A or Baker Full Opening Anchor Parallel Flow Tube Product No. 701-A
Baker Model "DA" Retainer Production Packer Product No. 415-DA
Casing
Baker Tubing Stop Product No. 704
Baker Model "D" Retainer Production Packer Product No. 415-D
Baker Spacer Nipple Product No. 470-E
Baker Model "E" Tubing Seal Nipple with One Seal Unit Product No. 448-E1
Baker Type "E" Full Opening Non-perforated Production Tube Product No. 457-E

Illustrates Two-Packer parallel string installation with each zone confined to its individual tubing string with full-opening to lower zone for use of all permanent-type completion tools.



Clean lines of barge below decks offer minimum resistance when barge is submerged.

Anti-scouring feature of hull is the sloping sides down to a 3-ft vertical skirt.



End view of "Mr. Arthur" showing 34-ft wide slot to accommodate up to three wells without refloating barge.

of 12 ft with a 32 by 34-ft drilling slot. Detachable side and bow wedges (hull extensions) increase the overall hull dimensions to 180 by 151 ft. A three-foot deep scour skirt, designed to prevent wash-outs under the hull, surrounds the entire hull periphery and sloping sides allow water action to pass up and over the hull with minimum resistance when in the submerged position. Storage is provided for 3200 bbl of drilling water, 750 bbl of fuel oil, and 750 bbl of potable water. Draft under loaded condition is 7 ft 8 in. Steel tonnage required was 2581 tons.

Located just aft of midships in the hull is the ballast pump room containing the following pumps: Four ballast and salt water service, auxiliary salt water, drilling water, sanitary water, potable water, and fuel oil. The two low head (50 ft) and the two moderate head (119-ft) centrifugal ballast pumps are driven respectively by 50 and 60-hp, 440-v, 3-phase, 60-cycle, electric motors. Local and remote push buttons are provided for control. The ballast manifold contains 16 motor operated valves, remote controlled, so that personnel are not required in the pump room during the actual submerging or refloating operation. Ballast water may be pumped from port to starboard tanks, or vice versa, as desired. Remote controls for pumps and valves are located in the hydraulic control room on the lower deck level.

Stabilizing features. Self-stabilization is obtained by four hull recessed pontoons, each with 1200 sq ft of bearing area, operated hydraulically by the mud pumps. The system is designed to permit controlled lowering and raising of the vessel between floating conditions and resting on bottom where the hull is completely submerged. Eight 39-in. OD hydraulic ram cylinders connect the hull and upper decks. Inside the ram cylinders are 36-in. OD ram columns, two of which are connected to each of the four pontoons, to provide means for keeping the barge level during raising and lowering.

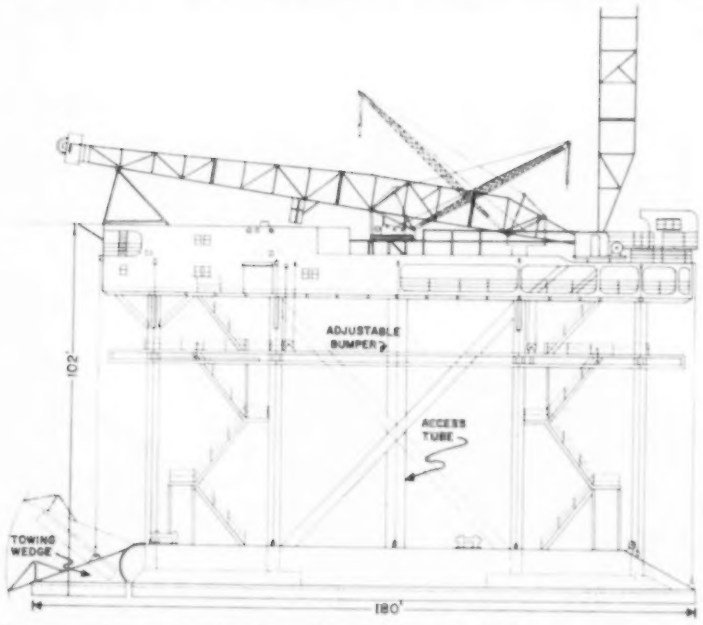
Controls and pontoon position indicators are located in the control room on the lower deck. Each pontoon may be operated individually or all four may be "interlocked," one as master and three as slaves, and operated together.

In the lowering operation, the four pontoons are pumped to bottom and firmly seated by pumping water on top of the 36-in. rams. The hull is then ballasted to provide negative bouyancy. Bleeding off of the water atop the 36-in. rams allows the barge to settle to bottom with the operator having complete and positive control at all times. In raising, the procedure is reversed.

Upper decks. The upper decks are supported on the above eight ram cylinders and two 60-in. OD access columns located at midship on either side. An elevator inside the starboard column provides access between the pump room in the hull and the upper decks. An emergency escape ladder and piping are located in the port column. Lower deck is located 84 ft above the hull bottom. Lower deck contains crew quarters, engine room, mud pits, mud pumps, cementing unit, and four anchor winches. Upper deck level contains additional quarters, well logging unit, cranes, pipe rack, and drilling rig. A helicopter deck is located atop the quarters area and is 102 ft above the hull bottom. Accommodations are available for 44 men.

Power Plant

Power for "Mr. Arthur" is provided by three diesel engine-generator sets

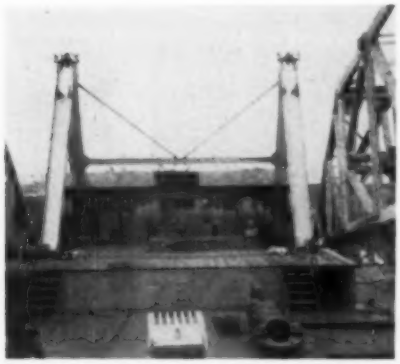


Towing wedge can be raised for moving when barge is afloat. Drilling mast is shown in the lowered and raised position.

each including one 850-hp diesel engine; two 500-kw, 625-v, main d-c generators; one 50-kw, 125-v, auxiliary d-c generator; and two 4-kw d-c exciters. In addition, two of the engine generator sets are equipped with one 300-kw, 480-v, a-c generator. The diesel engines are six-cylinder, in-line type, heat exchanger cooled, four-cycle, turbocharged, rated at 850-bhp at 1000 rpm. The d-c generators are rated at 500-kw, 800 amps nominal at 1000 rpm, with an overload capacity for one minute of 225 percent. Field windings are of differential compounded type which in conjunction with the excitation system design prevents overloading beyond safe limits.

The first generator is rigidly connected to the engine structure. This generator shaft is extended to drive the second generator and the a-c generator is driven by a shaft extension of the second generator.

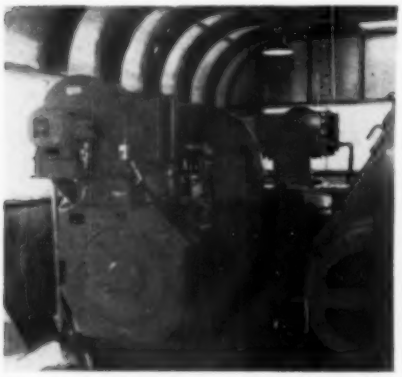
The electric motors which drive drawworks, mud pumps, and rotary are rated at 625-hp, 800 amps nominal, shunt-wound, separately excited, and are designed for operation in either



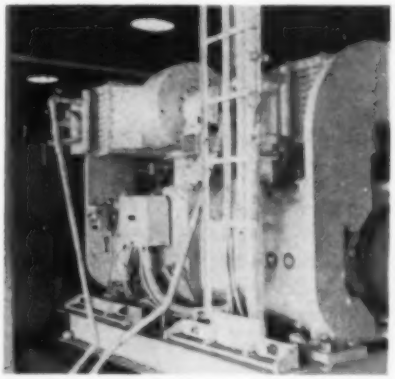
Derrick floor with unusually wide catwalk to accommodate side movement of elevated floor structure. Mast is in down position.

Drawworks, motors and mast mounted on large I-beam skids for lateral movement across drilling slot to permit drilling three wells without refloating.

Hydraulic rams position derrick floor structure on deck.



Two drilling motors, each rated at 675 hp, power drawworks. Note closed circulating air system on each motor.



Power for each mud pump is supplied by two 675-hp electric motors, totally enclosed and equipped with a closed air-cooling system. Cool water flows through heat exchanger coils in this cooling system.

Two 1000-hp mud pumps give "Mr. Arthur" the necessary hydraulic power to drill to its rated depth of 20,000 ft.

Arnold Lewis says..."When it comes to Slim Hole Drilling...

I use a

THESE FEATURES MAKE THE DIFFERENCE!

- Power take-off chain oil bath lubricated.
- Self-supporting mast under normal loads.
- Mast hydraulically raised, mechanically telescoped, 4 legs — in either truck or trailer mounted arrangement.
- Air compressor with complete air system and controls for drum clutches, engine clutch, and rotary drive clutch.
- Driller's position is forward . . . near the well and located at platform height for complete visibility and better access to derrick floor.

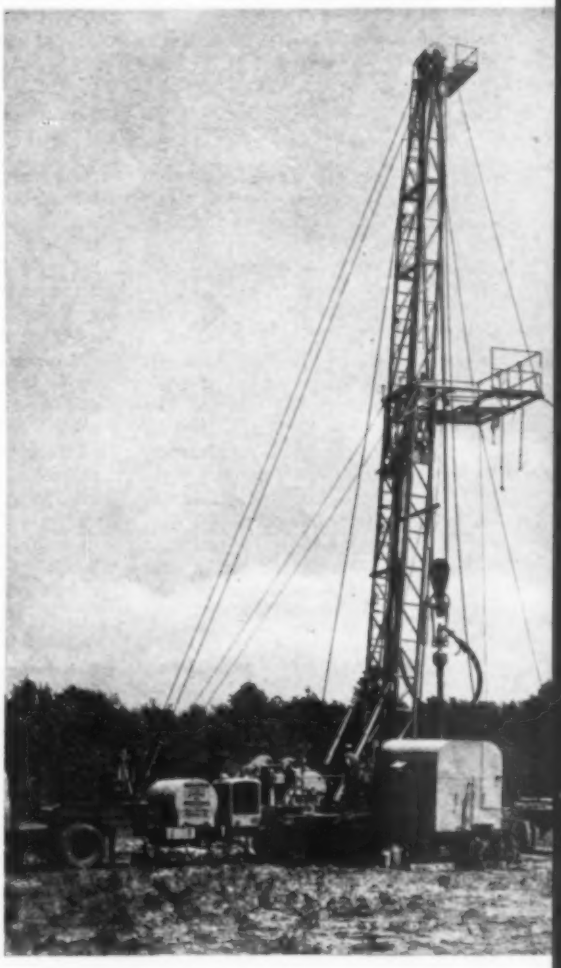
FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Three Man Crew"

Using a completely portable Cardwell Model AL rotary rig, equipped with a Cardwell Model 100 mast, Arnold L. Lewis – doing business as Lewis Drilling Company out of Princeton, Indiana – has found "reduced manpower . . . drilling equipment . . . and hole size makes Slim Hole Drilling with Cardwell equipment the most economical and efficient method for both producer and drilling contractor."

This Cardwell rig is handled very efficiently and economically by a three-man crew. Not only is there a decided saving in drilling and completion costs, but moving, rig-up and tear-down time are saved – adding to the efficiency of this type of Slim Hole drilling.

Cardwell's Model AL, a single-engine, mechanical-driven hoist, has a Slim Hole depth rating of 4,000 feet using 2⅞ inch drill pipe. For rotary drilling, depth rating is 2,000 feet with 4½ inch drill pipe or 2,500 feet with 3½ inch drill pipe. In servicing or rotary workover, the rating is 5,000 feet. Nominal input rating of the Model AL is 120 horsepower. New alloy steels make the unit tougher . . . but lighter. It is specifically designed to combine fast operating speeds with extreme portability.



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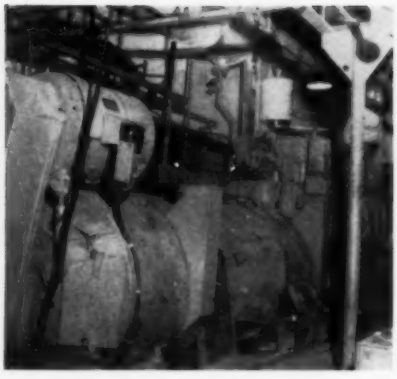
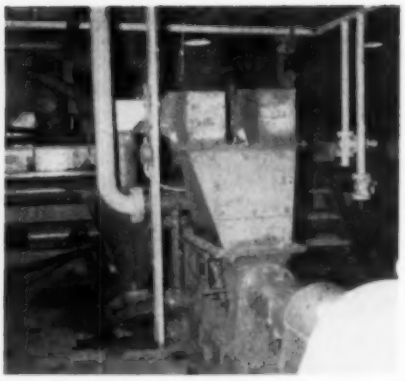
Electrical control panel is located on main deck near engine room.



Power plant is made up of three diesel engine generator sets. The one shown above consists of two 500-kw, 625-v d-c generators with a 50-kw 125-v d-c auxiliary generator mounted on top of end generator. Engine is rated at 850 hp.



Bulk mud handling is by this pneumatic unloader, eliminating usual hand operation. Dry mud is stored in bulk storage bins, and can be unloaded in the mixing hopper.

direction. Motors are made explosion proof by using a heat exchanger and closed air circulating system for cooling purposes. Design is such that only two engine generator sets are required for normal operation.

Drilling Equipment

The 142-ft, 1,000,000-lb capacity, 30-ft leg spread, full view, jack-knife drilling mast is the first of its kind. The drawworks has four speeds and is driven by two 625-hp electric motors. It is equipped with catheads, 1⅜-in. drum grooving, a 60-in. single hydromatic brake, and an automatic driller.

The 27½-in. rotary table is unitized with one 625-hp electric motor and automatic air slips. The two 1000-hp mud pumps are each driven by two 625-hp electric motors. Suction piping is laid out so that either pump may take suction from any of the four 300 bbl mud tanks. Pump controls are located at the pumps, driller's console, and in the hydraulic control room.

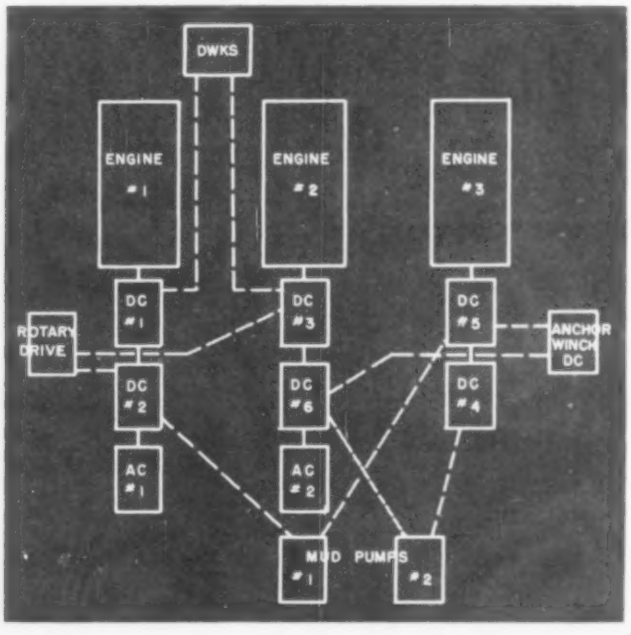
A degasser, shale shakers, and electric powered mud mixers are included in the mud system. The driller's console contains controls for the drawworks, rotary, mud pumps, and for selection of generators to power the above equipment. For safety reasons, the rheostats which control the electric motors are mounted in the engine room and operated with air valves from the driller's console.

Emergency shut-down controls are provided for both a-c and d-c equipment. The coring reel is driven by a diesel engine and unitized with a 60-kw, 440-v, a-c auxiliary generator. Drilling string equipment includes a 500-ton traveling block, 500-ton swivel, and 450-ton hook. Using hydraulic rams, the entire derrick and substructure may be skidded eight feet to either side of the center line of the barge thus allowing three wells to be drilled from one location without refloating the barge.

Bulk Mud System

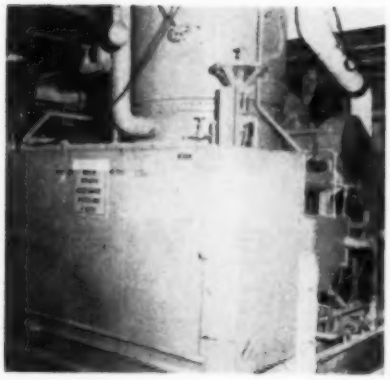
The bulk mud and cement handling system is another first for "Mr. Arthur." The system is composed of two parts. Located above the mud tanks

Electric power generation and distribution to main driving motors showing generator hookup and flexibility of distribution to driving motors.

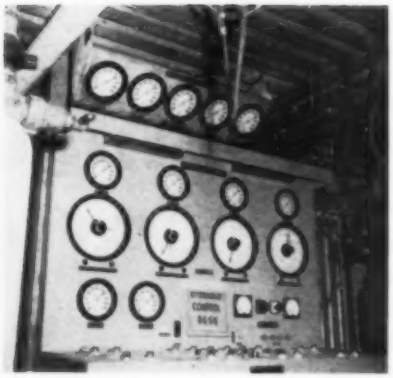


The Author

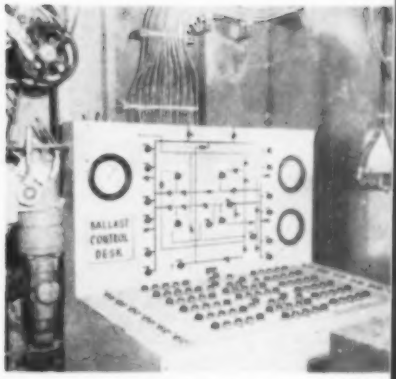
Harvey B. Elder, Jr., is currently serving as drilling engineer and relief toolpusher for Coral Drilling Company, with headquarters in Fort Worth, Texas. The author operates from the company's offices in New Orleans, Louisiana. A native of Arkansas, Elder entered Texas A&M College at College Station in 1938 and joined the U. S. Air Force in 1940 to serve as a pilot during World War II. He returned to Texas A&M to complete his BS degree in petroleum engineering in 1949 at which time he joined The Ohio Oil Company as a drilling engineer for their Texas offshore program. In 1951 he was made assistant drilling foreman for Ohio covering West Texas, New Mexico, and the Texas Gulf Coast. He became associated with Texas Crude Oil Company as a petroleum engineer for West Texas and New Mexico in 1954, and in 1956 was made drilling engineer for Coral to help in the construction of "Mr. Arthur."



Potable water from sea water is provided by two 300 gal per hr vapor compression distillation units. One is shown here.



Hydraulic control desk is the nerve center of the mud pump system. Suctions and discharges can be switched from tank to tank at this point. Driller also controls operation of pumps.



Ballast control desk provides a central point for controlling submergence and refloating operation. Operator can control all pumps and valves involved.

are two 1000-sack bins for dry bulk mud, one 1000-sack bin for gel, and two 1000-sack bins for cement. Bulk material is fed into mud tanks, or cement hopper, by air slides.

Located in the hull is storage for 4000 sacks of dry bulk mud and 2500 sacks of bulk cement. Bulk material is transferred from hull to upper bins using portable pneumatic "unloaders," or from upper bins to hull using a stationary dry mud pump. Any material remaining topside after a well completion will be moved to the hull for stability before refloating. The system provides the storage capacity and flexibility needed to meet offshore drilling requirements.

Auxiliary Features

The quarters area includes both deck levels. Siding is of aluminum plating. Eight four-man staterooms are located on the lower deck. The upper deck contains galley, mess room, office, five two-man staterooms, crew change room, crew lounge, and guest lounge for visitors.

Year round all-electric air conditioning is provided by two 15-ton units. Each room has an individual control. Two 300-gph vapor compression units provide potable water from sea water. One 15-ton and one 25-ton cranes are available for transfer of material to or from service boats. Four separate communication systems are installed: (1) Intership telephone, (2) radio telephone, (3) two-way FM radio, and (4) helicopter radio.

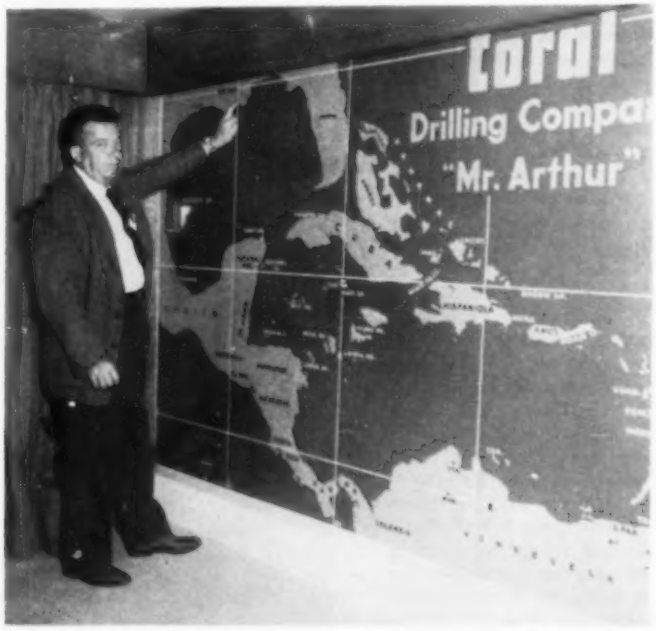
First Assignment

The "Mr. Arthur" is presently contracted to the California Company and is drilling in Block 45 of Main Pass area in 30 ft of water off the coast of the Mississippi Delta. Operations are not necessarily restricted to the Gulf Coast since, due to design and construction, the unit is fully capable of traveling to and working in any part of the world.

About Coral Drilling. Coral Drilling Company is a closed corporation owned by Arthur O. Wellman, Hall Haskell, LaMot DuPont Copeland, George Weymouth, Cosden Refining Company, and Ted Weiner. Officers are: Chairman, A. O. Wellman, Sr.; president, Ted Weiner; vice presidents, Tom Weymouth and Marvin Miller; treasurer, Bob Johnson; and secretary, Ed Hay. Operating personnel include W. B. (Bob) Stuard, drilling superintendent and G. L. (Pat) Gleason, toolpusher. ★ ★ ★

Pump room in lower hull which is submerged during drilling operations.

W. B Stuard, Coral's drilling superintendent, points to first location on inlaid linoleum map in guest lounge.



The Pure Oil Company's procedure for . . .

Completing a High-Pressure Offshore Well

A 17,000-ft deep wildcat in Eugene Island Block 32 experienced a bottom-hole pressure of 9650 psi, gas-cut mud and a failure in the lower section of casing. Here's how it was successfully completed

Harold Simpson
The Pure Oil Company
Houston, Texas

IN spite of high bottom-hole pressures, gas cut mud, a casing failure and deep drilling, The Pure Oil Company's Gulf Coast division completed its first high pressure well offshore in the Eugene Island Block 32 gas condensate field off the coast of St. Mary Parish, Louisiana. Drilled from a self contained platform to a total depth in salt of 16,868 ft, this well represents tenacious optimism on the part of the operator in the face of severe costs in attempting to drill as deep as possible. Footage costs offshore are accelerated with depth but are more noticeable when high pressure gas sands and salt water flows are encountered.

Field history. Eugene Island Block 32 field is located 34 air miles southwest of Morgan City, Louisiana, St. Mary Parish. By boat, the route traveled is down the Atchafalya River from Morgan City to the mouth of the river, thence to the location, a total distance of about 39 miles.

This field was discovered by The Pure Oil Company in December, 1949. Development drilling indicated a multiplicity of gas condensate pay zones down to depths slightly below 12,000 ft. Geologic and seismic information indicated evidence for accumulation in Miocene sands located above a typical deep seated dome. Considerable faulting is present with the major structure formed by a large graben accompanied by other faulting. A complex system of reservoirs resulted, all with various sizes and shapes. Analyses of reservoir rock indicated good porosity and permeability.

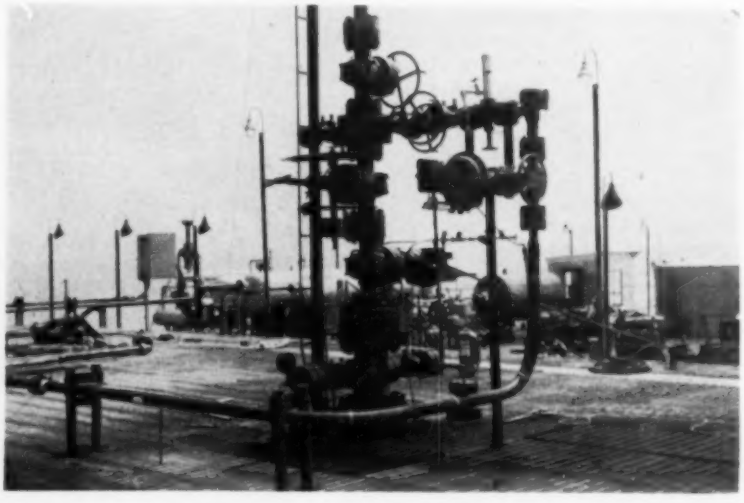
Development of the field continued until the latter part of 1951, when a gas contract was negotiated. Gas condensate production began in November 1951. During development proceeding and subsequent to initial gas deliveries, several platforms were installed utilizing each platform for multiple well drilling. By 1956, plans were completed to drill a well to explore deeper possibilities. All producing reservoirs completed to this time indicated a normal depth pressure gradient of about .465 psi per ft at the water contact.

To drill a well to 17,000 ft in the field necessitated certain minimum requirements. Previous drilling indicated a probable high pressure salt water flow at about 12,500 ft. Casing programs used for directional wells precluded adequate casing protection for a deep well. Other directional well drilling problems normally encountered indicated that a deep exploratory well should be a vertical hole for optimum drilling conditions. Hence the decision to drill State Lease 833 No. F-1 as the first well from "F" platform, which was so located that a completion could be made in a developed reservoir in case deeper horizons failed to yield production.

Drilling Structure

"F" platform was designed as a

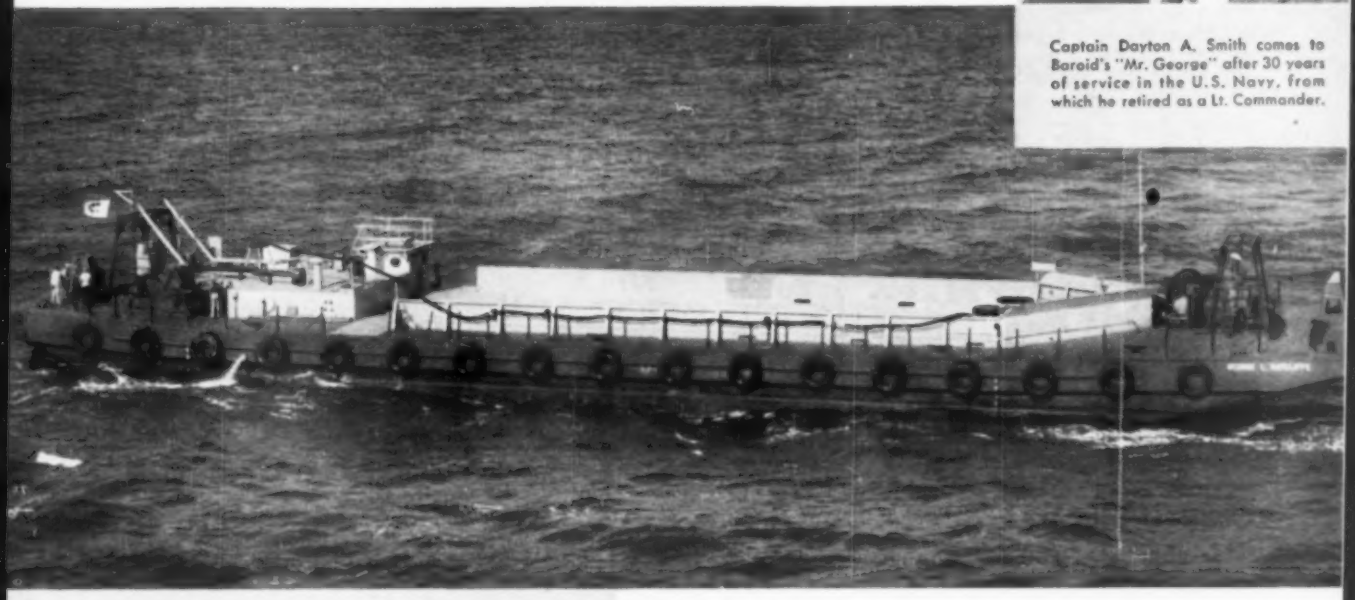
API Series 2900 tree used in completion of high-pressure gas condensate well. Safety equipment includes pneumatic valve operator on lower master valve, automatic shut-in valve on upper master valve, automatic safety valve on wing and a reducing regulator downstream from the choke.



"Allis-Chalmers Diesels on the 'MR. GEORGE' give wonderful service,"

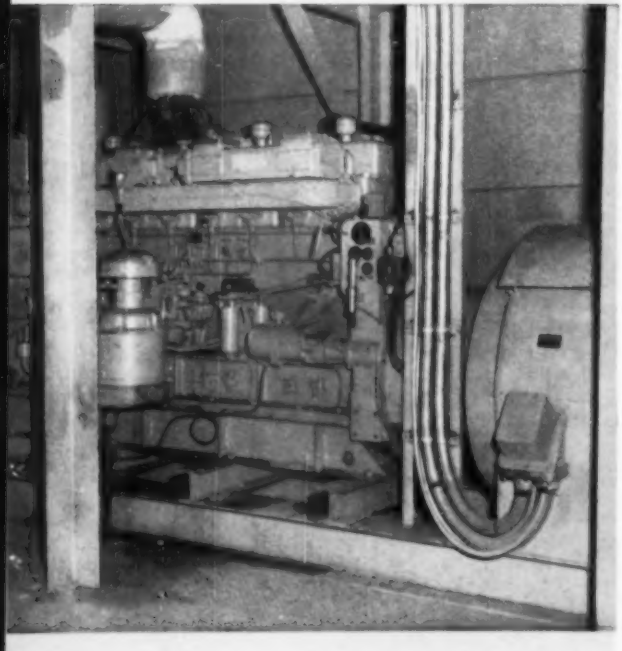
SAYS CAPTAIN DAYTON A. SMITH

Captain Dayton A. Smith comes to Baroid's "Mr. George" after 30 years of service in the U.S. Navy, from which he retired as a Lt. Commander.



The "Mr. George" is 196 ft long, 42 ft wide, 12 ft deep—has payload capacity of more than 1,500 tons of bulk BAROID* and other drilling mud additives. It carries Coast Guard Customs Registration and Star A-1 American Bureau of Shipping Certification.

*Registered trademark of Baroid Division, National Lead Company.



One of two Allis-Chalmers Model 2505 diesel engines driving 250-kw generators, providing power for propulsion, pumping, winches — all equipment aboard the "Mr. George."

BM-17

"And believe me," Captain Smith continues, "diesel engines operating under the exacting conditions found on a mud delivery vessel, such as the 'Mr. George,' get a real test for endurance and efficiency."

Power for equipment aboard the *George L. Ratcliffe* is furnished by two Allis-Chalmers Model 2505 diesels, each driving a 250-kw generator. There are two electrically driven outboard propulsion units with 54-inch diameter by 30-inch pitch propellers. These units are unique in that they can be rotated independently through 360 degrees and are reversible. Using them alone, the craft can be brought into position, held while mud deliveries are made, then backed away from the rig.

When the "Mr. George" went into service, it joined the growing fleet of Allis-Chalmers-powered vessels serving off-shore rigs. Before you specify an engine or generator set for any craft, see your Allis-Chalmers dealer for help in selecting the best unit for the job.

ALLIS-CHALMERS, BUDA DIVISION, MILWAUKEE 1, WISCONSIN

ALLIS-CHALMERS

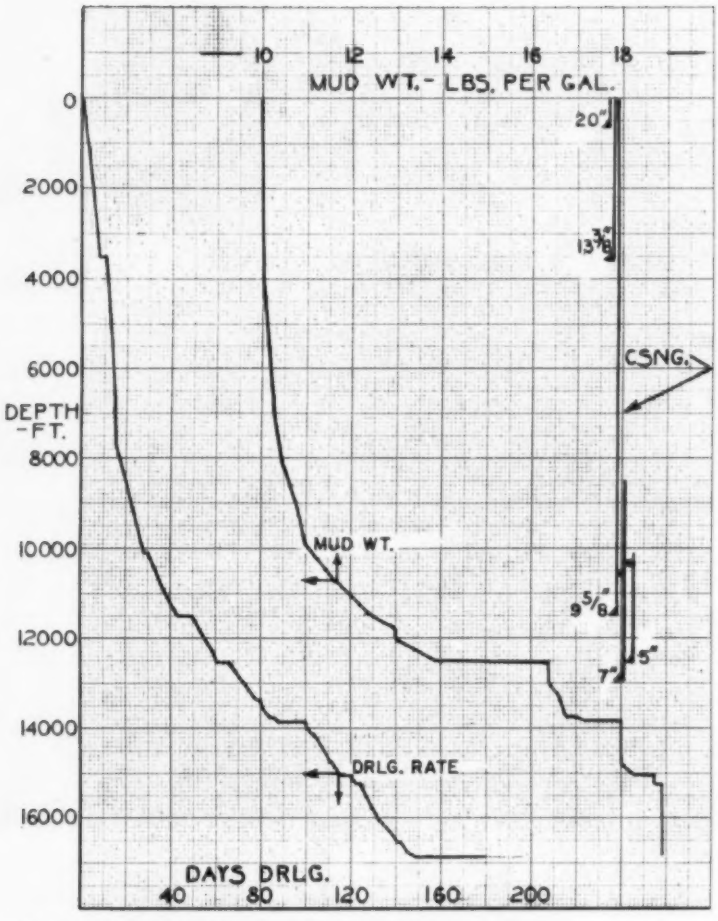


FIG. 1. **Well's graphic history** is clearly indicated by the drilling time curve, plotted along with mud weight for various depths. Casing program is shown at right.

multi-well drilling structure accommodating three well locations on 30-ft centers. Drilling structure consisted of a 42 by 100-ft eight-pile jacketed type steel platform, and a double decked 67 by 80-ft rig machinery and pipe rack platform constructed of timber piling. Water depth at this location is 10 ft. From the well structure deck to water level was 29 ft; the upper deck (pipe rack) of the double decked timber piling structure was 38 ft above the water, and the lower deck was 24 ft above water level.

The well structure consisted of eight 24-in. OD, ½-in. wall thickness piling driven through 28-in. jacket pipe. Ten feet of 18-gage monel sheathing was wrapped around each jacket leg at the water line for protection from severe corrosion at this point.

The entire platform was designed to accommodate a rig that would allow machinery to be installed beneath the pipe rack, and allow for skidding of the rig along the long axis of the well structure with the location of the V-door and pipe rack normal to this axis.

Drilling Rig

Loffland Brothers Drilling Company Rig No. 62 was used to drill the well. Loffland and Pure personnel jointly planned the rig type and layout to fit this particular job since this was the first job for the rig. The rig had a diesel electric drive utilizing three 520-hp V-12 diesel engines as prime movers for two 400-kw generators furnishing power to two 765-hp motors. Mud pumps used included an 850-hp, 8¼ by 18 in.; a 600-hp, 7¾ by 18 in; and a 220-hp, 7¼ by 12 in. The drawworks was rated at 1100 hp and has a 28 by 40 in. drum. Crown and traveling blocks had respective ratings of 600 and 500 tons.

A 4½-in. 16.60 lb per ft drill pipe was used until a 7-in. liner was set at 12,985 ft after which 3½ in. 13.30 lb per ft IF drill pipe was used. The drill collar program consisted of 6-8 in. OD collars for the surface hole to 3500 ft, 9-8 in. OD collars to 11,500 ft where 9⅝ in. casing was set, nine 5¾ in. OD collars to 13,824 ft where a liner was run but stuck at 12,985 ft, and eleven 4½ in. OD collars to total depth of 16,868 ft.

Three 280 bbl 8 by 7 by 28½ ft mud tanks were utilized.

The installation provided a compact rig lay-out with the engines, generators, mud tanks, mud hopper, mud pumps, tool house, mud storage, and auxiliary equipment located on the lower deck of the pipe rack structure.

DRILLING MUD PROGRAM

No particular mud problems exist in this field when drilling to 12,000 ft. In the upper section of the hole, mud was maintained at 10 lb per gal initial weight to 10.8 lb per gal at 9650 ft. A caustic-quebracho-CMC mud was used to 9650 ft. At this depth, mud was converted to a high pH, lime based, 10 percent diesel oil emulsion, starch mud. This type mud was used to drill to total depth; however, oil percentage was reduced to 8 percent below 13,600 ft. Properties of the mud below 10,000 ft are listed as:

Depth (ft)	Wt. (lb/gal)	Funnel vis (sec)	Water loss (cc)	PPM Chlorides
10,000	11.0	50	5.0	5,000
11,500	12.3	58	3.8	3,400
12,500	13.7	50	3.0	4,000
12,600	16.4	68	2.2	5,000
13,300	16.6	74	2.0	6,600
13,800	17.3	70	1.8	15,000
13,824	17.8	Ran 7" liner to 12,985		
14,000	18.0	74	3.0	10,000
15,000	18.2	76	2.1	10,000
15,100	18.7	75	2.2	12,000
15,500	18.9	80	1.8	15,000
16,000	18.9	90	1.5	13,000
16,500	18.9	90	1.8	10,000
16,868	18.9	85	2.0	8,000

A breakdown of total mud material cost showed 16.2 percent for mud to 12,000 ft, 36.6 percent from 12,000 to 14,000 ft, 39.4 percent from 14,000 to 16,868 ft, and 7.8 percent of total cost for testing and completion.

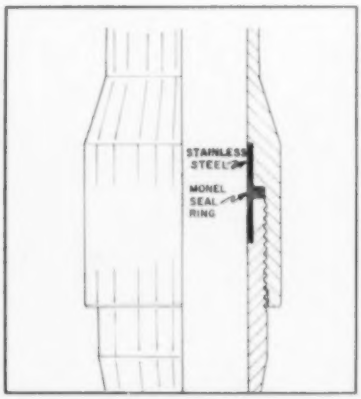
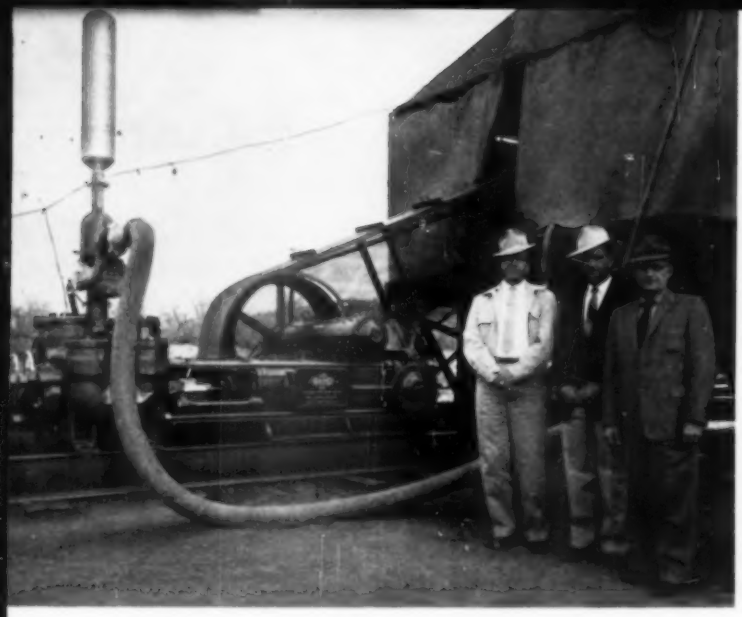


FIG. 2. **Special 3½-in. tubing joint** incorporated stainless steel weld lining and a monel pressure energized seal ring. Tubing was internally coated.



"This pump's performance was so satisfactory . . . bought a new (Wheland) HP-8000 pump for the smaller rig."

—J. W. Hastings

Here's the dependable Wheland HP-14000, still doing a fine job after 5 years in the field. Standing left to right, are Mr. J. W. Hastings, Owner; Mr. C. T. Coffman, Drilling Supt.; Mr. Joe Don Carlos, Wheland Rrepresentative.

J. W. HASTINGS
DRILLING CONTRACTOR
720-722 WICHITA NATIONAL BANK BUILDING
WICHITA FALLS, TEXAS

April 15, 1957

Mr. Gordon P. Street, President
The Wheland Company
Chattanooga, Tennessee

Dear Mr. Street:

I purchased one of your HP-14000 pumps five years ago which has cut a tremendous amount of hole with virtually no repair expense.

This pump's performance was so satisfactory that when I began acquiring new machinery, bought a new HP-8000 pump for the smaller rig.

Both of these pumps are still in operation and doing a satisfactory job.

I operate two rigs in North Texas area. We drill contracts, interest deals and for our own account, from 2,000 - 8,500 feet.

Yours very truly,

J. W. HASTINGS DRILLING COMPANY

J. W. Hastings

FIRST PUMP'S RECORD SOLD THE SECOND!

5-YEAR RECORD

OF OUTSTANDING PERFORMANCE

"virtually no repair expense"

—J. W. Hastings

WHELAND HP-14000

7½" x 14" DUPLEX SLUSH PUMP

350 Horsepower Nominal Input at 60 RPM
Discharge pressure with 7½" liners 838 PSI
Discharge pressure with 5½" liners 1627 PSI
Dependable Operation • Lower Maintenance
Delivers more pressure per pound of pump!

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CHATTANOOGA, TENNESSEE, U.S.A.

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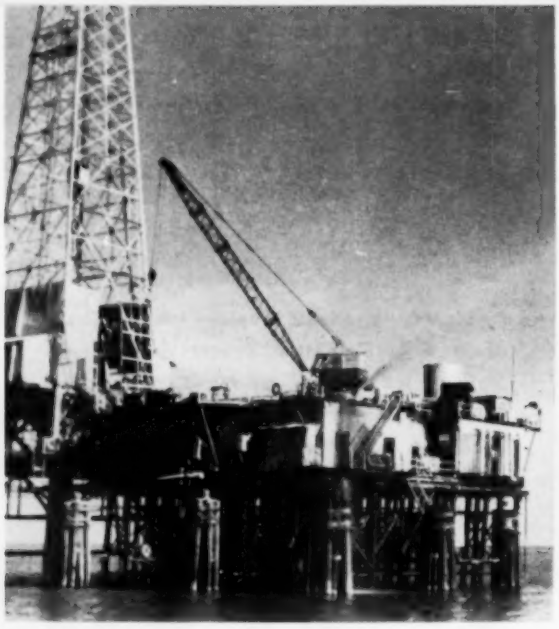


Multi-well drilling structure, platform "F," designed to accommodate three well locations on 30-ft centers, measures 42 by 100 ft.

Cleaning up well after completion by venting through manifold located at edge of platform. Flow line is 3½-in. OD with a ¾-in. wall thickness.

A summary of mud used includes approximately 42,000 sacks of weight material, 1300 sacks of clay and bentonite, 122,000 lb of chemicals, 820 bbl of diesel oil, and 2200 sacks of lost circulation materials.

The well first kicked mud at 12,500 ft. Blowout preventers were closed and the well circulated on a choke while increasing weight to 16.4 lb per gal. While drilling at 13,350 ft mud returns were lost; 447 bbl of mud were pumped into the formation while adding lost circulation materials. In drilling ahead to 13,824 ft gas cut mud required additional weighting to 17.2 lb per gal. However, returns were lost at 13,824 ft so the mud was slugged with lost circulation materials. A 7 in. liner was run but stuck off bottom at a depth of 12,985 ft. Further gas and salt water cutting required a mud weight of 18.7 lb per gal at a depth of 15,261 ft. The well started coming in at this depth with mud cut by salt water. After circulating and conditioning hole for two days, weight was increased to 18.9 lb per gal. The remainder of the hole was drilled with this mud weight with only a slight loss of mud on two separate occasions.

It is particularly significant that many short trips were required for mud conditioning after the mud weight had to be increased above 18 lb per gal. After each round trip to change bits and run electric logs, it was found that mud returns from bottom were badly gas cut.

Casing program. The following well casing program was used in completing the well:

30 in. ½ in. wall drive pipe to 168 ft

20 in. 94 lb per ft casing to 637 ft

13⅜ in. 72 lb per ft surface pipe to 3518 ft

9⅝ in. 40 lb per ft to 53.5 lb per ft to 11,501 ft

7 in. 32 and 35 lb per ft liner 10,486 to 12,985 ft

7 in. 26 lb per ft grade P-110 to liner sleeve at 10,486 ft

5 in. 18 lb per ft liner 10,300 ft to 12,548 ft

Total weight of casing: 635 tons.

After setting the upper section of 7-in. P-110 casing into a liner sleeve located on top of the lower 7-in. liner, a casing test revealed a failure in the lower section of 7 in. casing. This precluded a safe high pressure well completion, hence a decision was made to run a 5 in. liner.

Drilling and completion. Blowout preventers and choke manifolds were hydrostatically tested at frequent intervals during the drilling programs. Casing hanger type plugs were used for these tests. Test pressures were 3000 psi to a depth of 10,500 ft, 5000 psi to 14,000 ft, and 6500 psi below 14,000 ft. These tests were made at intervals of approximately 500 ft below a depth of 11,500 ft.

Rate of penetration below 12,000 ft averaged 8 ft per hr while drilling. However, more time was spent circulating and conditioning mud than drilling. From 12,000 ft to total depth actual drilling accounted for 27.6 percent of total time, circulating accounted for 42 percent, round trips, 18.1 percent, and other operations accounted for 12.3 percent of total rig time. Forty-five days were spent drilling with a mud weighing 18 lb per gal or greater; during 30 days of this period the mud weight was 18.9 lb per gal. Continued careful surveillance of the mud was necessary under these conditions. A mud de-gasser was used to help remove entrained gas. Considerable success was obtained with a mud de-sander in the upper section of the hole.

When drilling at a depth of 13,824 ft with 2323 ft of open hole below 9⅝-in. casing, 17.8 lb per gal mud was severely gas cut. Continued increase in weight resulted in lost returns. After conditioning mud a 7 in. OD liner was run.

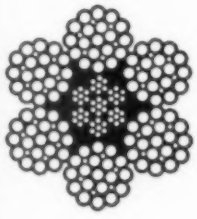
The troublesome mud problems at 13,824 ft required five continuous days of mud conditioning prior to running the 7 in. OD liner. Drilling was then resumed with increased mud weights. On two other occasions mud was circulated for three continuous days while increasing weight. After drilling into salt, at total depth, the drill pipe stuck but was worked loose.

After running logs and sampling the sands with side wall cores a decision was made to perforate and test the gas sand at about 12,500 ft which tried to blow out when first penetrated. A cement retainer was set at 12,906 ft and 150 sacks of cement were pumped into the formation. A squeeze cement job was performed below the 12,500-ft sand after which the well was perforated from 12,536 to 12,556 ft for testing.

Drill stem testing. In planning a test of the zone the anticipated pressure could only be estimated. It was definitely known that this section flowed 15.6 to 16 lb per gal mud back through the drill pipe, hence the pressure was

WICKWIRE

DOUBLE GRAY



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LOOK FOR THE YELLOW TRIANGLE

3078

Hi-pressure wire line lubricator is used to run storm choke and bottom-hole regulator. Gin pole was especially made for raising the heavy-duty lubricator.

Size of high-pressure tree is indicated by Pure Oil engineer Ed Reardon standing alongside.

estimated to be about 10,000 psi. In planning the drillstem test, provision was made for running a full water cushion in the drill pipe; if the well were to flow back, it was planned to set a maximum surface working pressure limit before closing the tool. This pressure was arbitrarily selected as about 4500 to 5000 psi.

When the drillstem test tool was run, the hydrostatic head of the water cushion was equivalent to 5450 psi. The mud head at this time was equivalent to 11,100 psi. After the tool was opened the surface pressure built up to 4000 psi in ½ minute and 4100 psi in one minute. During this interim, three barrels of water were measured out. Tool was then closed so that the water cushion could be reversed out. The cushion was reversed out on a ⅛ in. choke; as gas from bottom hit the surface it was flowed through a ⅜-in. choke on the blow-off manifold. Data obtained from the test indicated a bottom-hole flow pressure of about 9600 psi.

Before running the upper section of 7-in. casing to form a complete 7-in. production string, it was decided to set a drillable retainer with 50 sacks of cement above the production perforations for safety reasons. A 7-in. OD 26 lb per ft P-110 T&C casing was then run and set with a sealing nipple into a sleeve which had been provided above the 7-in. liner packer. Mud weight behind the 7-in. casing was 17.0 lb per gal. Before lowering the 7-in. pipe into the sealing nipple, 450 sacks of slow set cement plus 15 percent 20-40 mesh Ottawa sand were displaced around the bottom of the casing. Sand was used in order to obtain additional weight.

Due to apparent leaks in the lower section of 7-in. casing as well as inconclusive success with cementing the outside, a 5-in. 18 lb per ft liner was set from 10,300 to 12,548 ft. It became rather obvious that a lost returns zone was partial cause of the trouble.

Running tubing. After perforating the 5-in. liner from 12,472 to 12,520 ft and 12,530 to 12,545 ft, tubing was run into the well for final completion. Tubing string consisted of 2230 ft of 2⅜-in. OD, 4.70 lb per ft, grade N-80 on bottom and 10,190 ft of 3½ in. OD, 10.3 lb per ft, .289 in. wall, grade N-80 on top. All tubing was internally coated with a baked on phenolic plastic.

The 2⅜ in. OD tubing was integral joint; a joint test was made to 9500 psi (74 percent of minimum yield of pipe) as the pipe was being run. The 3½-in. OD tubing joint incorporated the pressure energized seal ring. This joint was tested as the pipe was run; test pressure was 10,500 psi (about 80 percent of minimum yield of pipe).

In order to eliminate the possibility of cracking the phenolic coating at each joint, a specially designed feature was incorporated in the joint itself. Other gas condensate wells in the field had experienced a cracking of the internal coating at the joint but with no other damage. A monel seal ring was used. A weld lined seat of type 347 stainless steel was welded into both pin and box ends of each joint. The stainless steel was welded into each end after boring out. Total length of the stainless section is about one inch; therefore it extends about ⅝ in. on each side of the monel ring and enables the internal coating to overlap the stainless section. Thickness of the weld lined seat is about ⅛ in., thinning at the seating surface.

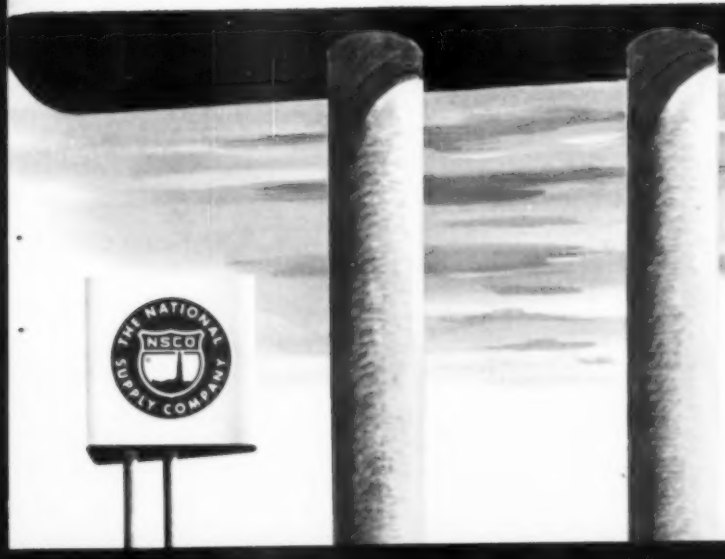
Testing procedure. The well was tested by unloading the tubing and venting gas off the edge of the platform. A special blow-down manifold and high pressure blow-down line was constructed for this purpose. The Christmas tree rating was API Series 2900. Flow line between the tree and edge of the platform consisted of 3½ in. OD, ¾ in. wall, pressure tubing. A Series 2900 cross with double wing valves and choke bodies was installed at the edge of the platform. For clean-up, the full well pressure was throttled slightly at the Christmas tree with the major pressure drop taken at the manifold on the platform's edge. In this manner the flow line pressure was not allowed to exceed 6500 psi by control of the positive choke bean size at the manifold relative to the choke bean size in the tree.

After cleaning up the well, an open flow potential test was run. Final shut-in surface pressure was 8100 psi and calculated bottom-hole pressure was 9650 psi. Well was loaded with oil and two blanking plugs were installed in selective landing nipples in the tubing string. Rig was then skidded to the adjacent location on the platform.

The time and efforts spent by all individuals connected with this well completion project cannot be estimated. The well is a credit to the drilling crews and local supervisory personnel who faced a challenging task. ★ ★ ★

The Author

Harold Simpson is division production engineer for The Pure Oil Company's Gulf Coast division at Houston, Texas. A native of West Texas, he received his BS degree in petroleum engineering in 1941 from The University of Texas, and joined Pure Oil as a roughneck on a company rig. He worked in various assignments in Texas and Louisiana. He entered military service in 1942, serving as an Air Force meteorologist in the Pacific theater with the aviation engineers. In 1946, he returned to Pure's Gulf Coast producing division, becoming assistant division production engineer in 1953 and division production engineer in 1956.



It pays to get this "shopping habit"!

In today's rush of getting everything done yesterday, do you often order operating supplies at the rig? Have you gotten out of the habit of dropping in at the supply store? If so, you may be overlooking the important advantages you gain from careful "in the store" buying.

Continued on next page

Look at it this way—the National Supply Store in your area anticipates your operating needs, stocks only top quality tools, parts, accessories and supplies. Most of these items are displayed in bins, counters and warehouse areas for your personal inspection, comparison and selection. You can *choose* the items that best meet your special needs. You will also find that the National store crew is a virtual encyclopedia of information on equipment ratings, advantages and the kind of performance you can expect from any item.

Occasionally, you may need an unstocked item. They'll order it for you on the spot, make sure it is sent the fastest way possible.

The small amount of time it takes to do "in the store" shopping and *planned* buying can save you money and time—savings you can't make buying at the rig on an emergency order basis. Moreover, you'll be better informed on the newest products available for your use.

Planned National Supply Store buying will give you more on-the-job time and greatly reduce the necessity for emergency orders. Let the National Store personnel near you show you how it really pays to get this "shopping habit."

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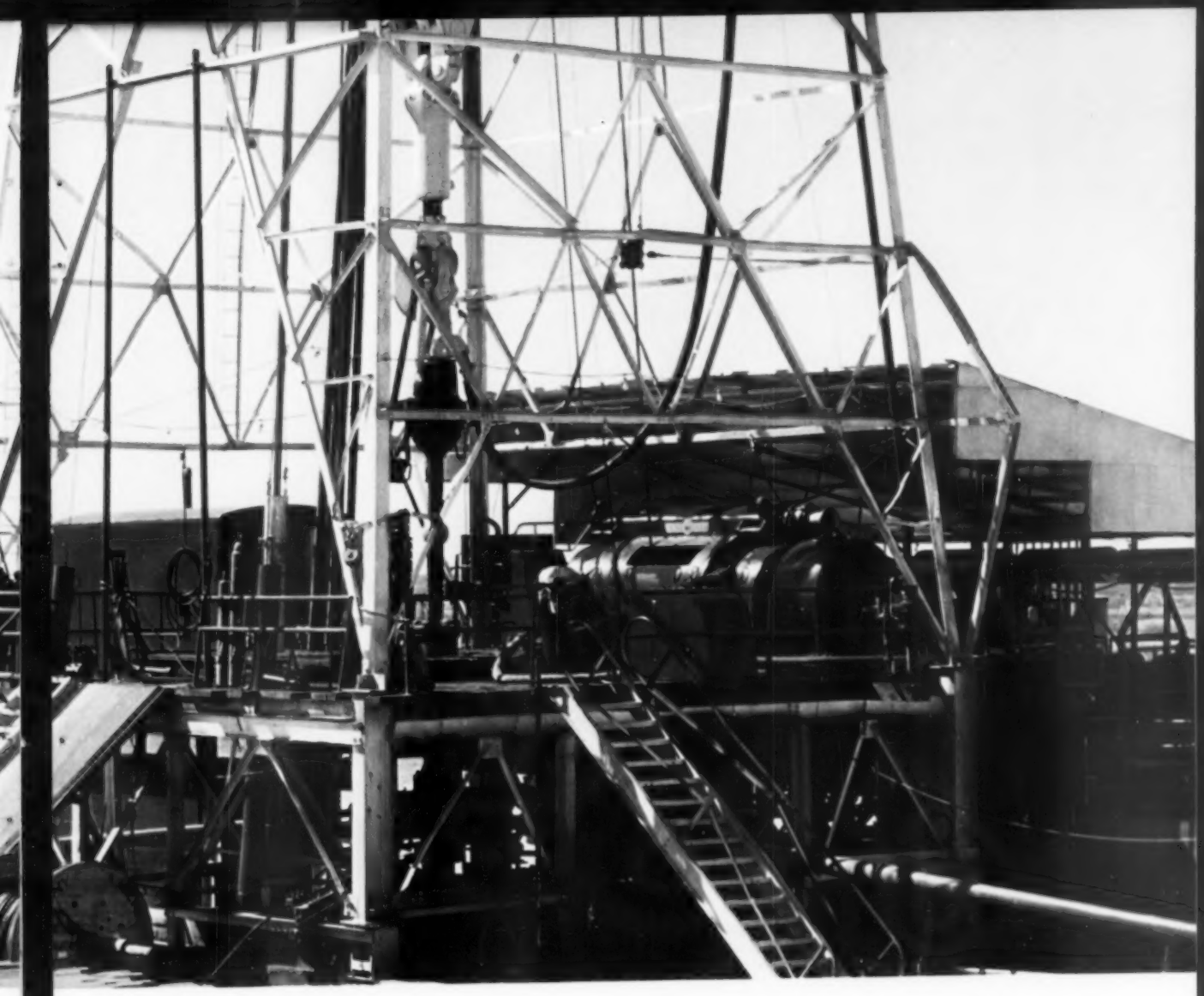
SPANG STEEL PIPE AND ELECTRICAL CONDUIT



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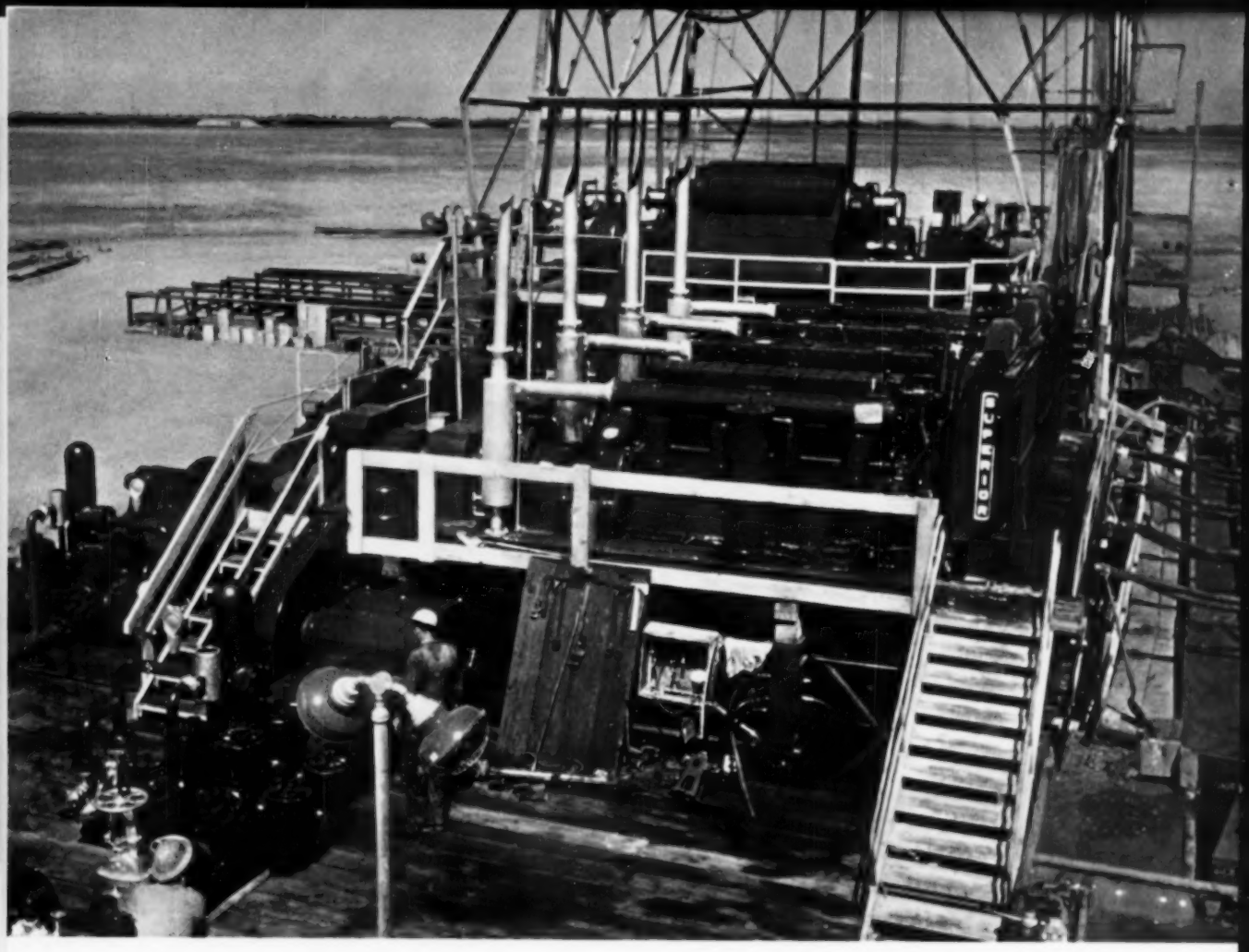
Want effective power transmission? See next page



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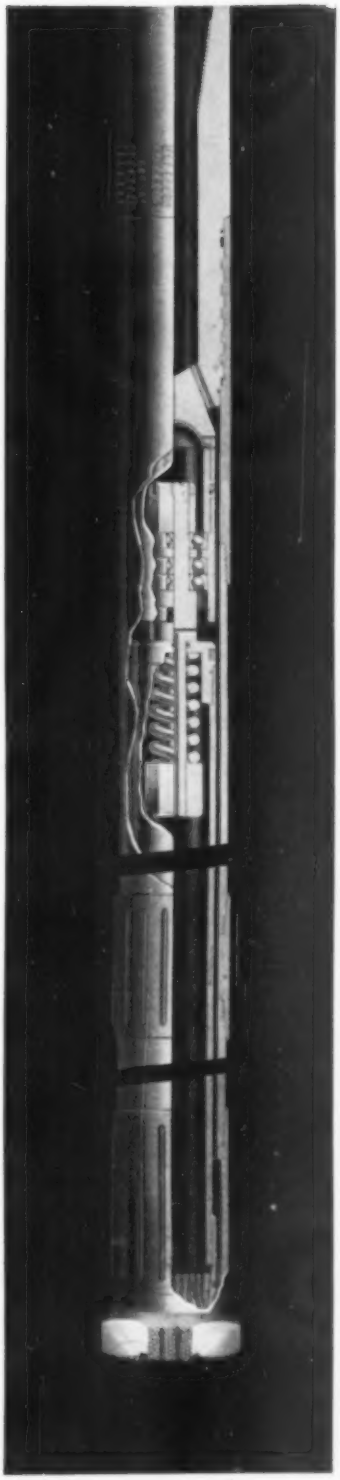

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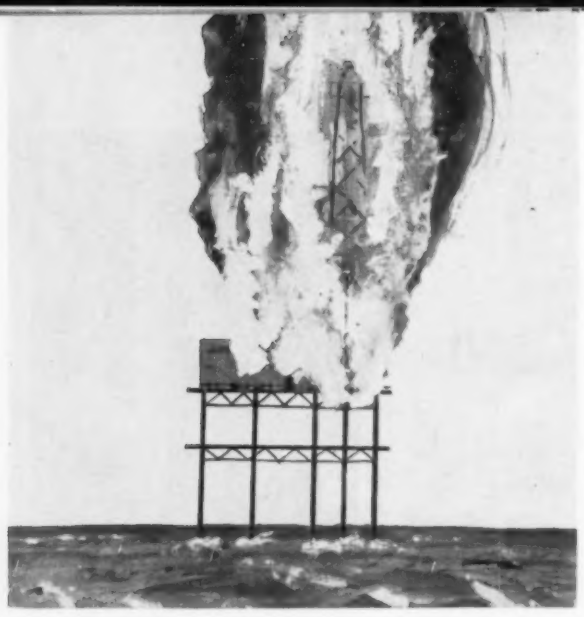
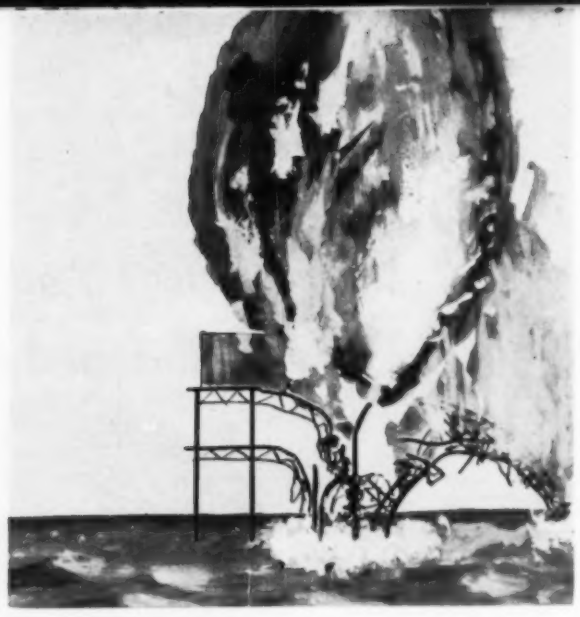


1 **BLOWOUT!** . . . the most dreaded word in the industry. It's usually worse at sea.



2 **DESTRUCTION!** When the rig crashes down, it usually further damages control equipment.

A recent development by three companies. It's a *New Method* of

Controlling Wild

It's so simple you'll wonder why you didn't think of it yourself, and it probably will work on any well where the blowout is at the surface

ONE dismal rainy morning not long ago, 17 oil industry scientists and engineers sat in parked cars near the outskirts of Houston, Texas, peering past flashing blades of windshield wipers at dripping workmen who were latching a hinged cylinder around a short upright piece of 7-in. pipe.

The men watched intently as a crane lifted a 14-ton jug-like caisson high in the air and smoothly lowered it over the cylinder. One by one they left the dry sanctuaries of the cars as a workman hammered up the handle-bar union that connected a high pressure pump truck parked at one side with the top of the caisson through a steel "hose" whose jagged silhouette was barely visible through the drenching rain.

Two of the engineers had come all the way from Venezuela to observe this demonstration, others came from Tulsa and Houston. Their purpose: to witness this test of two pieces of equipment that may lop days and even months off the duration of many devastating blowouts. *If successful, savings to the industry could possibly run into the hundreds of millions!*

A moment later the pump on the truck roared into life and the final test of an entirely new method of controlling surface blowouts was underway.

Why did this group of men set such store on the outcome of this test? If you're in the oil industry, you probably know the answer. The blowout or well out of control is the worst disaster that comes to the oil fields. It brings destruction—sometimes death—and almost always severe economic losses. But until now, little has been done to improve methods of combating it.

"A BLOWOUT IS EVERYBODY'S BUSINESS"

A blowout is the most dreaded thing that comes to the oil field. It brings destruction and wanton waste — it is the ultimate in hard luck.

But when it comes, rivalries between companies are forgotten — every one pitches in to help control the blowout — even at a financial loss sometimes.

Perhaps this is why Creole Petroleum Corporation (who promoted this new approach), The Carter Oil Company (who researched it) and McEvoy Company (who engineered and manufactured the equipment) are developing this device for the benefit of the industry.

— The Editors.

3 **DIRECT FLAMES UPWARD** and extinguish fire. Perhaps a wire rope saw is the answer.

4 **"WRAP-AROUND"** latches onto surface pipe. It seals like a casing hanger.

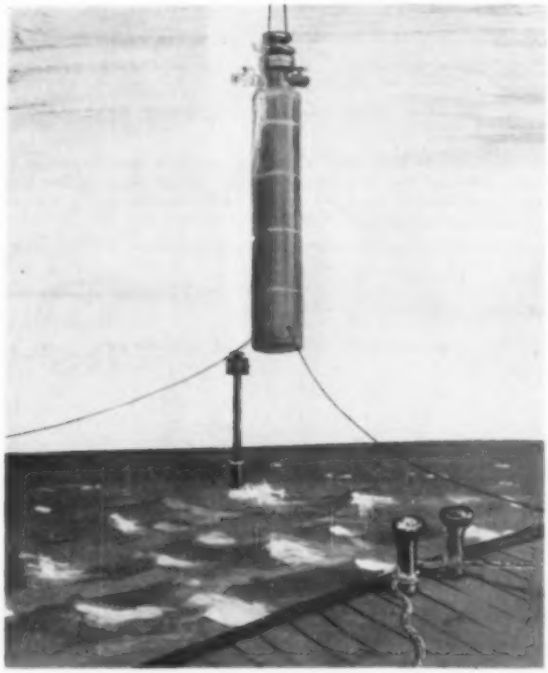
Wells

Donald M. Taylor *Gulf Coast Editor*

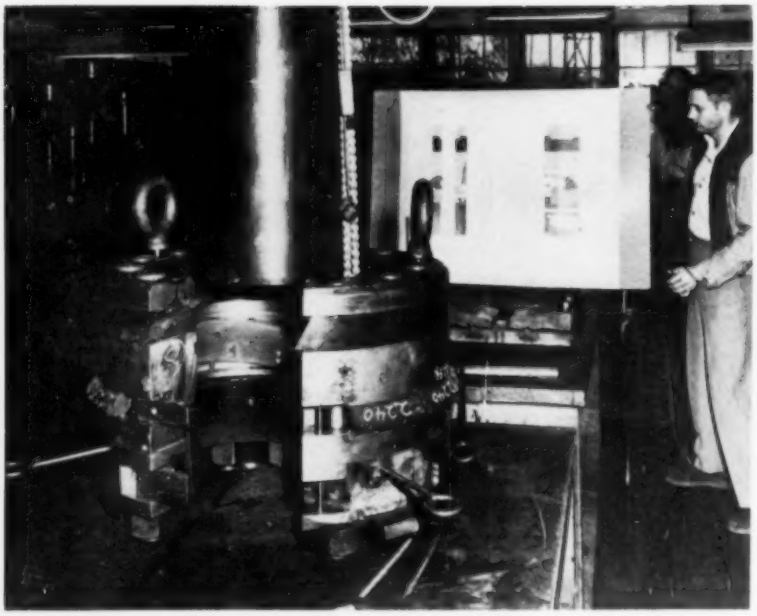
Blowout!

There's nothing in the oil field more terrifying and dramatic than the moment high-pressure oil or gas bursts out of control with an ear-splitting roar and explodes in a fiery cloud. From this spectacular birth until its death, the wild well lives a life of extravagant waste. The earth's rich gift of hydrocarbons spew skyward in a holocaust —produced so rapidly that more often than not, the reservoir suffers severe damage. This may greatly reduce the ultimate recovery of minerals left in the ground after the well comes under control. This devastating loss coupled with the destruction of surface equipment and the fantastic cost of battling a blowout may run the red ink into as many as seven figures for a single well!

As a matter of fact, the cost of combating a wild well sometimes runs so high that if the choice of fighting or not fighting it were resolved purely on economic factors, oil operators often



5 **CAISSON WILL CENTER OVER WELL BLAST.** It is then lowered onto "wrap-around."



Wrap-around unit. Note two sets of slips inside. Sealing element is the black hycar ring near the top.

would gain by pulling up stakes and letting the well blow or burn itself into extinction. But there are laws forbidding the practice, and even if there weren't, most operators feel a moral obligation to prevent this wanton waste of natural resources.

Summed up, a blowout is like a war: the quicker it's stopped, the less its destruction.

Yet, despite the urgency of winning a quick battle over a wild well, there's been little concerted effort throughout the industry aimed at devising new methods and new equipment for this purpose.

The reason? Plaguing the thoughts of every operator in the industry is this one fact—nearly every single blowout that's ever occurred could have been prevented one way or another.

This explains why the industry has poured vast sums into developing equipment to *prevent* rather than to *stop* blowouts. And as a result valves, blowout preventers, pipe, wellhead equipment and mud programs are improving every year.

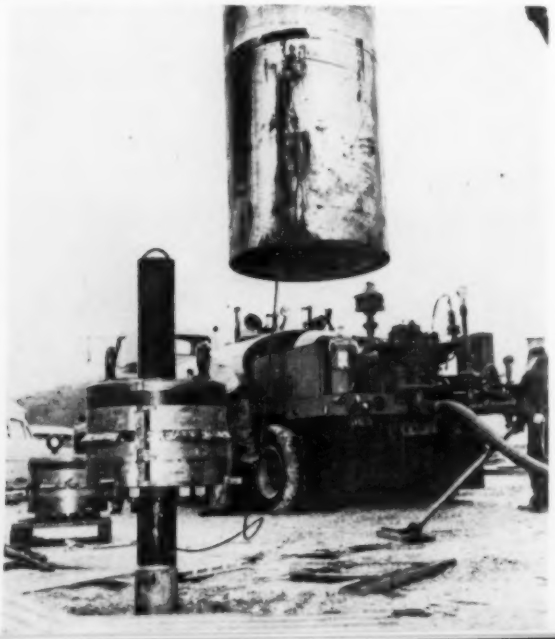
Even so, the probability of many future blowouts remains, and it's no wonder the group of men watching the test in Houston were oblivious to the rain as the technician on the truck filled the caisson with water and pushed the pressure higher and higher toward a final test of 5000 psi. This was one of the first new methods and equipment developed in years for the control of a wild well. And most of the men watching had had a direct hand in its design and engineering.

Three Companies Developed Method

Where did this idea come from? Actually three different companies had a hand in developing it, but credit for its conception goes to Creole Petroleum Company (Venezuela) engineers. On occasion in the past, they have faced the difficult task of killing a wild well in Lake Maracaibo in Venezuela. Once they improvised equipment similar to this and it worked so well, Creole turned the idea over to The Carter Oil Company research group for further development and later to the McEvoy Company for engineering and manufacture.

How does the new method work? It's so simple you'll wonder why you didn't think of it yourself. It involves two devices: One is a heavy caisson; the other, a "wrap-around" sealing device.

14-ton caisson overshot is lowered over 7-in. pipe to which has been attached the wrap-around. Inside bottom edge of the large caisson is bevelled so it will center itself over the sealing element. Latching grooves hold it in place.



Caisson locks onto wrap-around. Pressure from well (in this test, from a pump truck) causes wrap-around to seal. When test pressure reached 5000 psi, upward thrust on dogs of wrap-around was about 2½ million lb.

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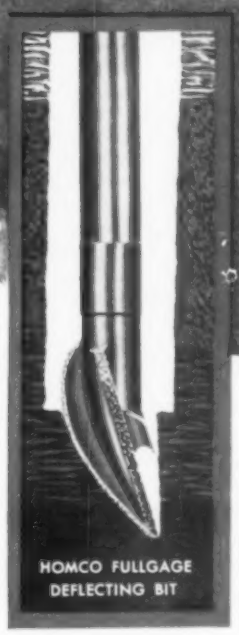

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Think of the caisson as an oversize candle snuffer, (just like the ones used in many churches) and the "wrap around" as a modified casing hanger that will seal both outwardly and inwardly when a vertical load is applied. The latter piece of equipment latches around the surface pipe of a wild well in much the same manner as oilfield elevators. When it is in place, the caisson can be lowered over the well head and locked into a series of "dogs" on the "wrap-around."

When valves on top of the caisson are closed, pressure from the well tries to force the caisson upward. But this force is opposed by the "wrap around" which grips the casing and seals against both casing and the caisson.

Note that so far as the sealing is concerned, the "wrap around" is acting just like an automatic sealing casing hanger when it takes the weight of the casing—only in this instance it's the upward thrust of the caisson rather than the downward pull of the casing that actuates the sealing device.

Take a look at the accompanying drawings and photographs and you'll see just how the new method works. But keep in mind that the method primarily is designed to combat surface blowouts.

As a matter of fact, in order for the method to work there must be some point at or near the surface of the ground below which there is pressure tight integrity. Also, there should be at least two feet of exposed surface casing. The method will be of little value in combatting a well whose casing has ruptured down the hole and the blowout is into the formation (and perhaps channeling up the hole). This type blowout can reach catastrophic proportions requiring that a "killer" well be drilled directionally to intercept the well at the producing formation.

But where a blowout is at the surface, the new method may quite possibly provide the solution. Let's take a look at a hypothetical blowout where the equipment could be used.

Unit's Offshore Use

Regardless of the cause of an offshore wild well, whether during the course of drilling, testing or completion, when the spewing gas and liquid hydrocarbons ignite, a terrible night mare ensues for all concerned. The heat is so intense the derrick collapses and much of the supporting structure may melt down rendering all possible control out of the question.

If we were members of the "task force" whose job it is to bring the well under control, our first job would be to mobilize units of the petroleum industry's offshore "navy." This would include two or three derrick barges, pump and mud barges, auxiliary tugs, etc. In the attack on the blowout, our first objective is to remove sufficient wreckage so we can get at the surface pipe that extends a short distance above the large conductor.

Next, we attempt to direct the flames upward and extinguish them. Our best bet is to remove the tree at the tubing head, diverting the flow upward. This makes the fire fairly easy to extinguish either by water, explosives, or chemicals.

Once we reach this point the rest of the battle is easy. We simply float the "wrap around" into the surface pipe on wire ropes, latch it, then lower the caisson over the well head and lock it into the "wrap-around." When the valves on the caisson are closed we start pumping against the well with water and finally mud.

But, say the task of removing the tree at the tubing head is too difficult to accomplish under the conditions that plague operations in the offshore water. So, instead, we remove the wing valves on the tree (the master valve is open) and lower the caisson over the remainder of the tree onto the "wrap around" as before.

Another way to direct the flow upward would be to saw the tree off — either above or below the tubing head. This has been done experimentally with wire rope fitted with cutters.

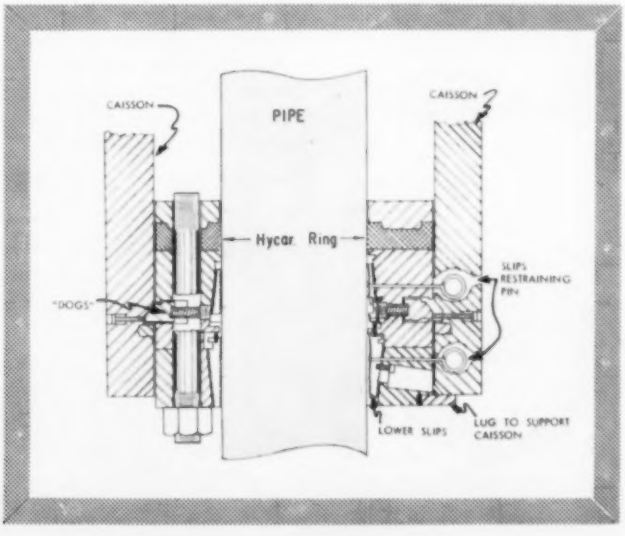
How Unit Can Be Used on Land

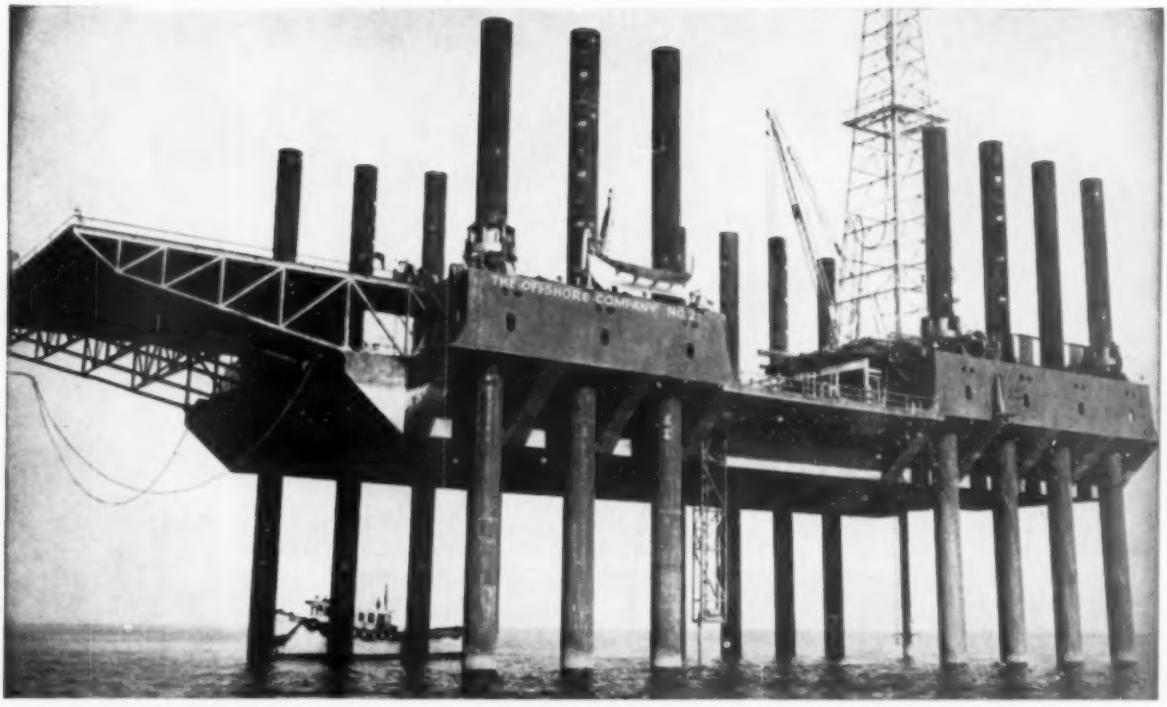
For obvious reasons it's usually easier to control a blowout on land than on water, but let's take a look at just one of the ways the equipment can be employed ashore—say on a West Texas wildcat.

In this case, the filler line valve failed when the driller closed the blowout preventers to stop a high pressure gas-condensate flow. In the explosion that followed, the rig was destroyed, and once again we have the task of removing wreckage to get working room at the pipe. As offshore, the big problem is to direct the flame upward and extinguish it. If pressure isn't extreme (enough to squirt the drill pipe from the casing) it might be possible to cut the casing and drill pipe below the pre-

Removing caisson. Pins are inserted in caisson to release dogs. Witnessing test is Victor Horner, The Carter Oil Company, (in rain gear at right of caisson) who helped research on equipment.

Wrap-around and lower end of caisson, shown in cross-section. Wrap-around is 20-in. high. As caisson pulls upward, dogs compress hycar ring against upper metal ring held down by bolts and lower slips. Pins restrain slips while wrap-around is installed.





OFFSHORE COMPANY'S MOBILE RIG 52 on location 45 miles southeast of Cameron, La. The Queen of the Offshore fleet is operating here in 58 feet of water, with a planned hole depth of about 9,000 feet.

EXCEPTIONAL COMMUNICATION NEEDS OF OFFSHORE COMPANY MET BY GENERAL ELECTRIC KNOWHOW

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Another unique feature of Offshore's General Electric radio system is electronic selective paging. This allows the Baton Rouge dispatcher to sound a buzzer on the desired offshore or inland rig when no one answers his call. The buzzer, which can be heard throughout the rig, greatly increases the speed with which radio messages get through to the person sought.

The equipment operated by Offshore includes 250-watt General Electric two-way radio stations on 15 rigs and 60-watt units in 13 company cars. The company reports excellent ranges and dependability from all its radio units...over land *and* over water.

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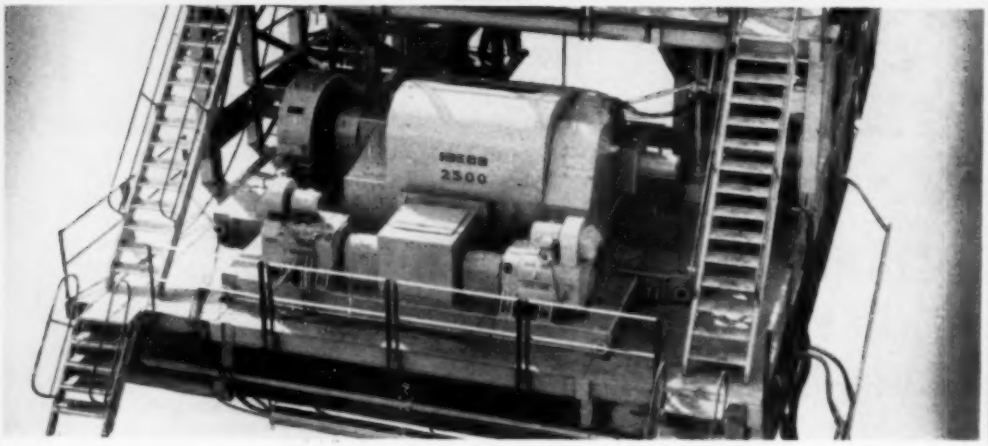

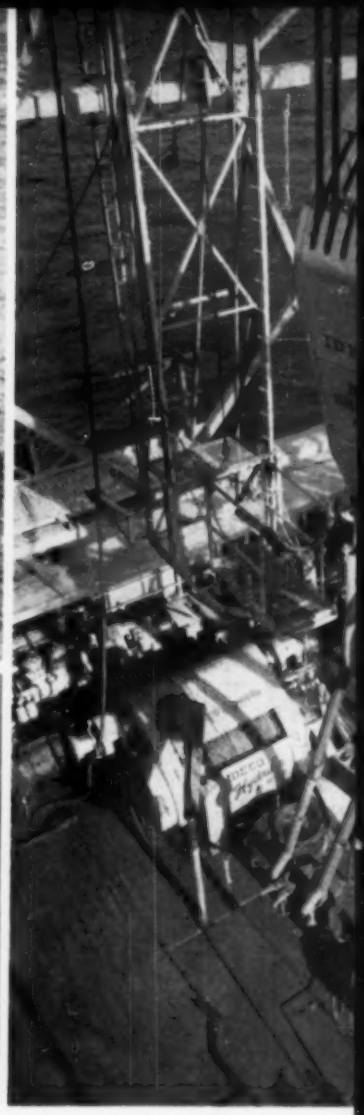

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MAGNET COVE BARIUM CORP., Houston, Tex.—Magcobar* and Magcogel* drilling muds and other specialized oil well drilling fluids and chemicals.

PACIFIC

PACIFIC PUMPS, INC., Huntington Park, Calif. — Centrifugal pumps for refineries, power stations, pipelines, and chemical plants; plunger pumps for oilwells.

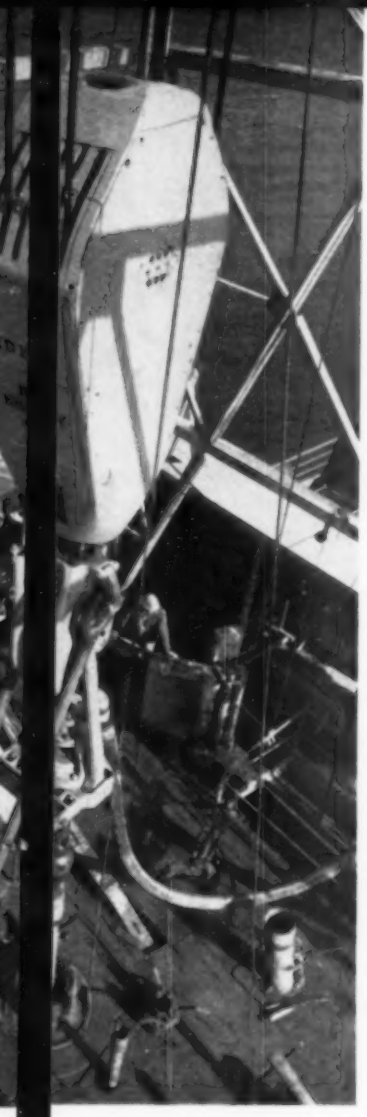
ROOTS-CONNERSVILLE

ROOTS-CONNERSVILLE BLOWER DIVISION, Connersville, Ind.—Rotary positive blowers, gas pumps, centrifugal blowers, exhausters, vacuum pumps, and positive displacement meters.

SIE

SOUTHWESTERN INDUSTRIAL ELECTRONICS CO., Houston, Tex.—Seismograph systems and instruments—electronic, electro-mechanical. Computers—analog and digital; recording systems. Special transformers, reactors.

Tomorrow's Progress Planned Today



How the DRESSER *plus* + works offshore

Dresser Industries, Inc. and New York Shipbuilding Corporation have formed a seagoing team to provide two specialized ships and technical equipment for an unusual type of offshore drilling installation. This offshore project is now being built for Coastal-Marine Drilling & Construction Corporation, under an initial $3,500,000 contract, and consists of the fully equipped, self-propelled drilling tender, the cargo supply ship, and the complete platform drilling rig, illustrated upper left. Dresser plus + equipment featured on this versatile, highly mobile drilling unit includes an Ideco diesel electric E-2500 double-drum rig complete with two Ideco skid-mounted slush pump assemblies, 560-ton crown block, 400-ton Big Shorty traveling block, and 27½-inch streamlined rotary table.

Your offshore work can profit in many other ways through the unique ability of the Dresser team to meet the most exacting requirements of exploration, drilling, and production techniques Other Dresser seaworthy service and equipment ready to serve at offshore drilling sites includes SIE seismograph systems, Magcobar specialized muds and chemicals, Lane-Wells technical oilfield services, Security drilling bits, and Guiberson oil tools with a variety of applications.

The Dresser operating companies work independently to provide a wide range of specialized equipment to meet your most difficult drilling requirements . . on sea or on land. Yet, *all* are teamed together with their combined facilities and experience to provide Dresser plus + equipment and services – the standard of comparison the world over!

IDECO®

IDECO, Dallas, Tex.—Hydrair* and Power Rigs; Full-View* Masts; substructures; single, dual and Drive-In Rambler Rigs; blocks, swivels, rotaries; mud pumps; petroleum equipment and supplies.

Security

SECURITY ENGINEERING DIVISION, Dallas, Tex., Whittier, Calif. – Rock bits, reamer rock bits and hole openers; reamers, casing scrapers and Neo-Red rubber stabilizers.

*Trademark registered

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venters. Perhaps this can be done with wire rope, shaped charges or projectiles. After the flame is out, we latch the "wrap around" on the pipe and cap the well with the caisson.

Where the blowout happens on a producing well it might be necessary to excavate to get to the surface casing. One way to do this is to set draglines on opposite sides of the well—a hundred feet or so from the hole — link their buckets together and "yo-yo" the dirt from around the surface pipe.

Engineering of the Equipment

While it is true that only two elements go to make up this "blowout kit," actually a different "wrap around" is required for every size of casing or drill pipe it must seal against. But aside from the differences of inside diameter, all of these units are identical. They are about 20 in. long and hinged so they can be latched around the surface casing or drill pipe as the case may be. On the inside are opposed sets of slips that grip the pipe to keep the device from moving up or down—even under extreme loads. The outside diameter of the "wrap around" is a uniform 25 in. except for the dogs that circumscribe it near the middle. The latter are nothing more than latches that hold down the caisson when it is lowered over the "wrap around."

The ingenious feature of the device that makes it feasible is that when pressure is applied to the caisson and it tries to lift the "wrap around" through the dogs, the action is opposed by a set of slips forcing a heavy hycar seal to expand against the surface pipe and the inside of the caisson. The resulting seal will readily withstand pressures in excess of 5000 psi.

Actually, the limiting factor—so far as pressure is concerned—is the crushing effect the slips exert on the surface pipe. After all, you can't engineer pipe that's already in the hole. Both sets of slips, however, are designed to exert a minimum crushing force, and the trick that makes it possible is that teeth have been cut on both the inner and outer faces of the slips.

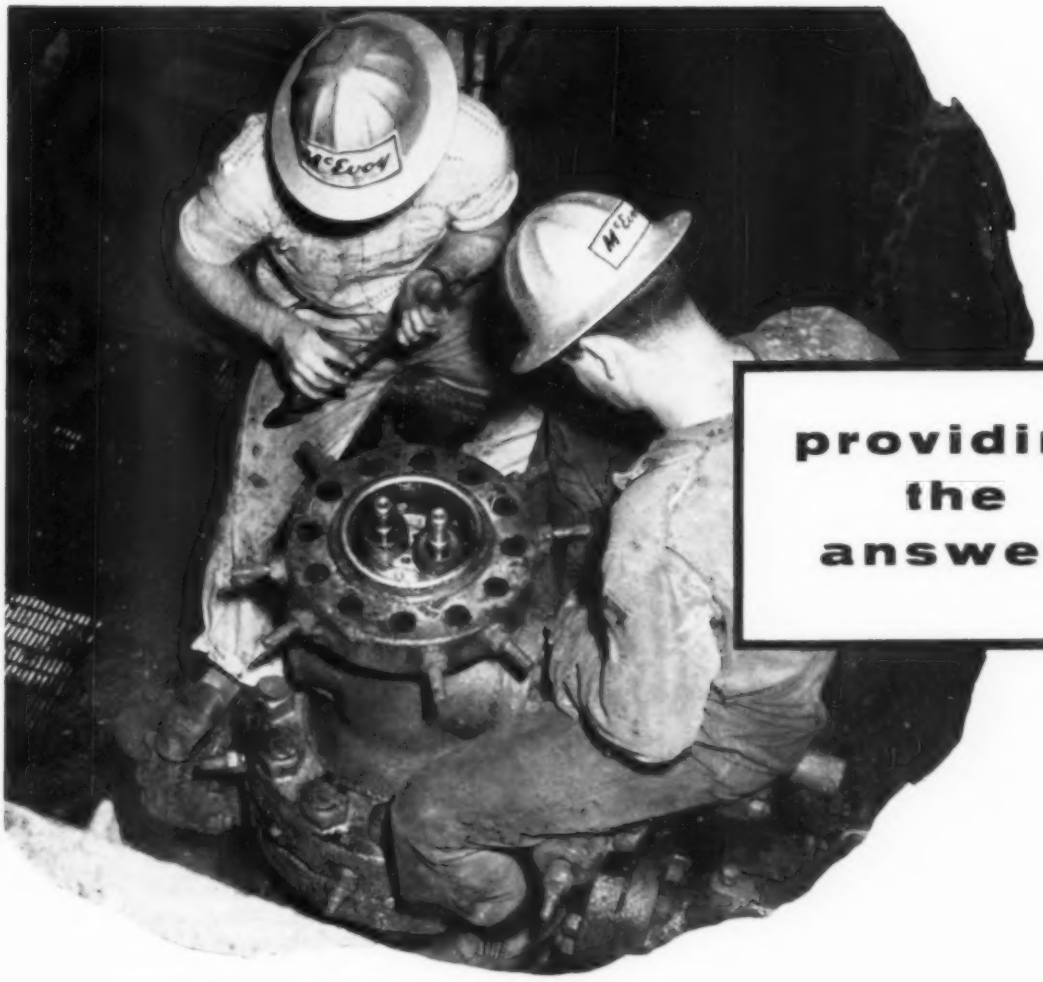
You almost have to see the giant caisson to believe it. It is a marvel of manufacturing know how; its walls are 5½ in. thick (the thickest wall vessel ever constructed by National Tank in its Tulsa plant) and its weight is better than 27,500 lb without valves, etc. The lower end of the 18-ft long open ended vessel is beveled toward the outside so the caisson will be-more-or-less self-centering once it straddles the blast from the well.

The great strength of this equipment was well demonstrated in its final test in Houston. Yet, the engineers and scientists who had traveled great distances to participate in the test must have felt at least a twinge of doubt as the pressure gage climbed toward the final 5000 psi mark. For they knew that at this figure, the total upward force against the dogs on the wrap around would be about 2½ million pounds; and there were other critical parts that had to withstand equally brutal forces.

As the pressure inched upward, their glances centered alternately on the dull form of the caisson and the yellow face of the pear-shaped gage. But when the gage finally read 5000 psi and a technician on the truck spun the valve closed, their air of taut expectancy evaporated. They knew they had developed equipment that likely will save millions of dollars—and many lives as well! ★ ★ ★

Plant inspection of wrap-around. C. F. "Cy" Johnson of the McEvoy Company, (center right) explains workings of wrap-around to oil industry group in Houston plant.

Designers and developers of blowout equipment are, left to right, Victor Horner, The Carter Oil Company research laboratory, John Ortloff of Carter, on loan to Creole Petroleum Company, E. F. Whittingdale, drilling equipment engineer, and R. W. Beck, drilling engineer, both of Creole's Caracas division, and three McEvoy engineers, Gus Gondran, design engineer, Allen Rhodes, director of engineering, and John Beson, assistant director of engineering.



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solution to your completion problems.

The *flexibility* of McEvoy well head equipment permits construction of Christmas trees to meet requirements of all wells, regardless of depth, pressure or completion method. The *interchangeability* of McEvoy well head components makes it easy and inexpensive to adapt trees to meet changing conditions from completion to depletion.

And McEvoy "know-how" is your assurance of *dependability*. Such exclusive features as McEvoy-Otis back pressure valves, to provide positive protection during all completion operations, and McEvoy *"Controlled Friction"* Casing Hangers, which completely eliminate "'pipe bottlenecking," are but two of the results of McEvoy's continuing program of engineering research.

Look to McEvoy for positive answers to your completion problems.

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Eastern District API Names New Officers

Appointment of new officers and the presentation of 12 technical papers, one which dealt with the use of air photographs to find new oil fields, closed the annual Eastern District meeting of the American Petroleum Institute Division of Production meeting in Pittsburgh, Pennsylvania.

More than 600 oil men from Pennsylvania, New York, West Virginia, Kentucky, Ohio, Illinois, and Indiana registered during the three-day meeting.

New district officers named were: Eastern District Chairman Lysle R. Kirk, Ohio Fuel Gas Company, Columbus, Ohio; vice chairmen: R. C. Curtis, Carter Oil Company, Mattoon, Illinois; L. T. Evans, East Ohio Oil Company, North Canton, Ohio; Millard Flood, the Ohio Oil Company, Terre Haute, Indiana; J. Robert Hornor, Delaware Gas Company, Clarksburg, West Virginia; R. J. Murdy, New York State Natural Gas Company, Pittsburgh; H. J. Magner, Delta Drilling Company, Pittsburgh; Wendell Moore, Columbian Carbon Company, Charleston, West Virginia; Quentin Wood, Quaker State Refining Company, Bradford, Pennsylvania; Dean Russell, Gordon Drilling Company, Mt. Pleasant, Michigan.

Also named to official positions were Harry T. Heuple, Manufacturers Light and Heat Company, Pittsburgh, as district secretary-treasurer, and Douglas Rogers, Jr., South Penn Oil Company, Bradford, as chairman of the district advisory committee.

The paper dealing with air photography, technically entitled "Airphotos in the Oil and Gas Industry" was presented by Theodore A. Cheney, The Air Force Center, Cornell University, Ithaca, New York.

Papers on hydraulic fracturing, cementing volume, drilling practices, natural gas operating practices, production, waterflooding, oil recovery, conservation, and fresh-water fracturing developed group discussions throughout the three-day meeting on the most up-to-date methods now used in the petroleum industry.

Serving on the general arrangements committee were Chairman Heuple, G. G. Bauer, *Producers Monthly*, Bradford; Ralph N. Burns, The Chartiers Oil Company, Pittsburgh; Paul G. Freund, Peoples Natural Gas Company, Pittsburgh, and Magner. Clifton Heathcote, New York Natural Gas Corporation, Pittsburgh, chairmanned the program committee; Bauer was chairman of the publicity committee.

Prominent speakers in the petroleum and allied industries were featured. Presiding were John T. Galey, independent producer, Mt. Lebanon, Pennsylvania, and Paul G. Benedum, Hiawatha Oil and Gas Company, Pittsburgh. Welcoming remarks were made by Douglas Rogers, Jr., South Penn Oil Company, and district chairman of the Eastern Division of Production.

Park H. Martin, executive director of the Allegheny Conference on Community Development, Pittsburgh, opened the general session with an address entitled, "The Pittsburgh Renaissance," followed by D. L. Connelly, vice president, Warren Petroleum Corporation, Houston, Texas, speaking on "What's Ahead for the Domestic Oil Industry."

Connelly presented four 1957 API "Citations for Service" awards. Recipients were Paul Benedum, Hiawatha Oil Company, Pittsburgh, R. G. Strong, Natural Gas Pipeline Company of America, Chicago, John Buckwalter, Ryder Scott Company, Wichita Falls, Texas, and W. B. Simpson, Hope Natural Gas Company, Clarksburg, West Virginia.

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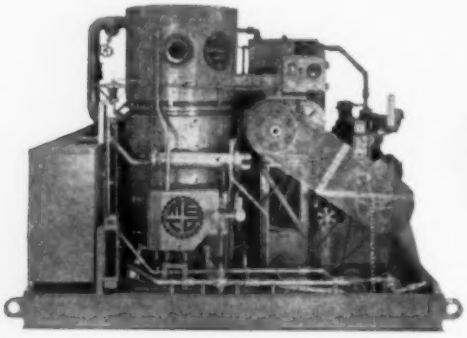

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MECO units are manufactured in New Orleans, and complete parts stock, as well as factory servicemen, are always available.

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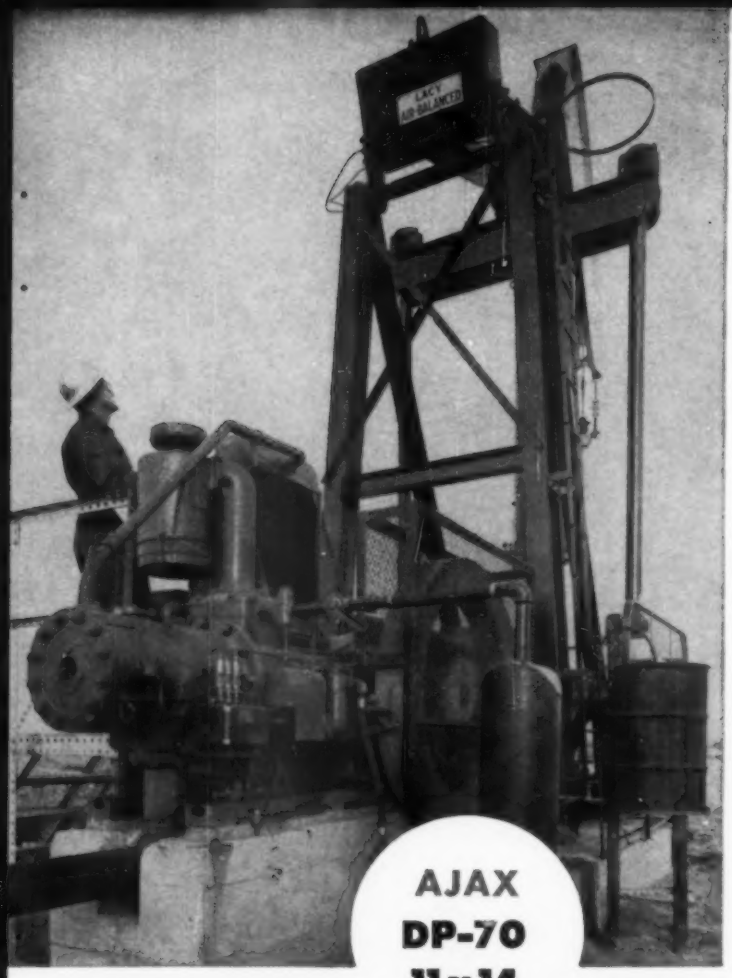

AJAX
DP-70
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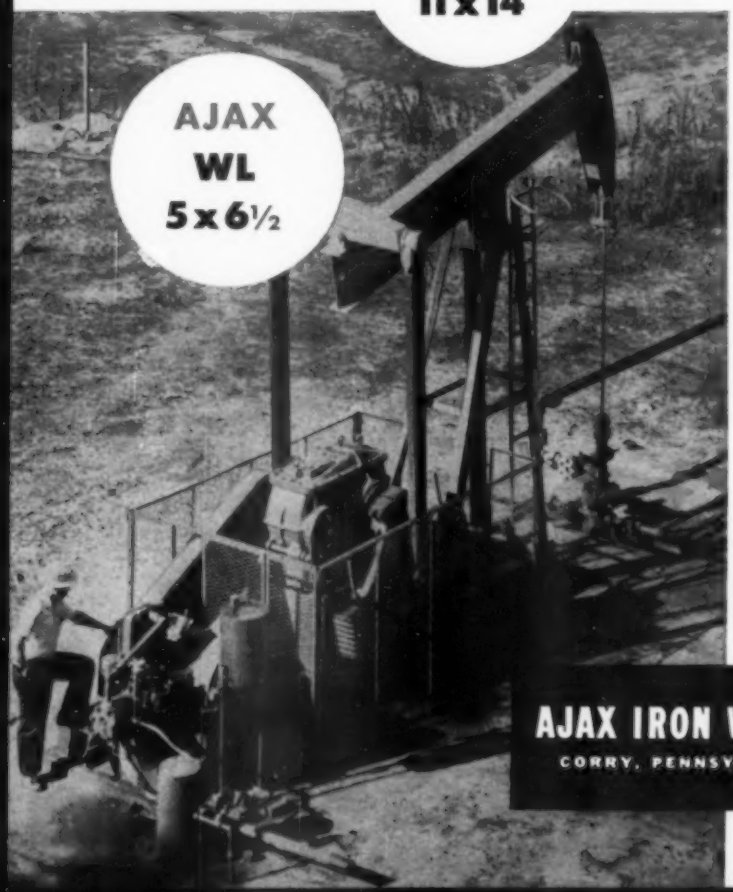

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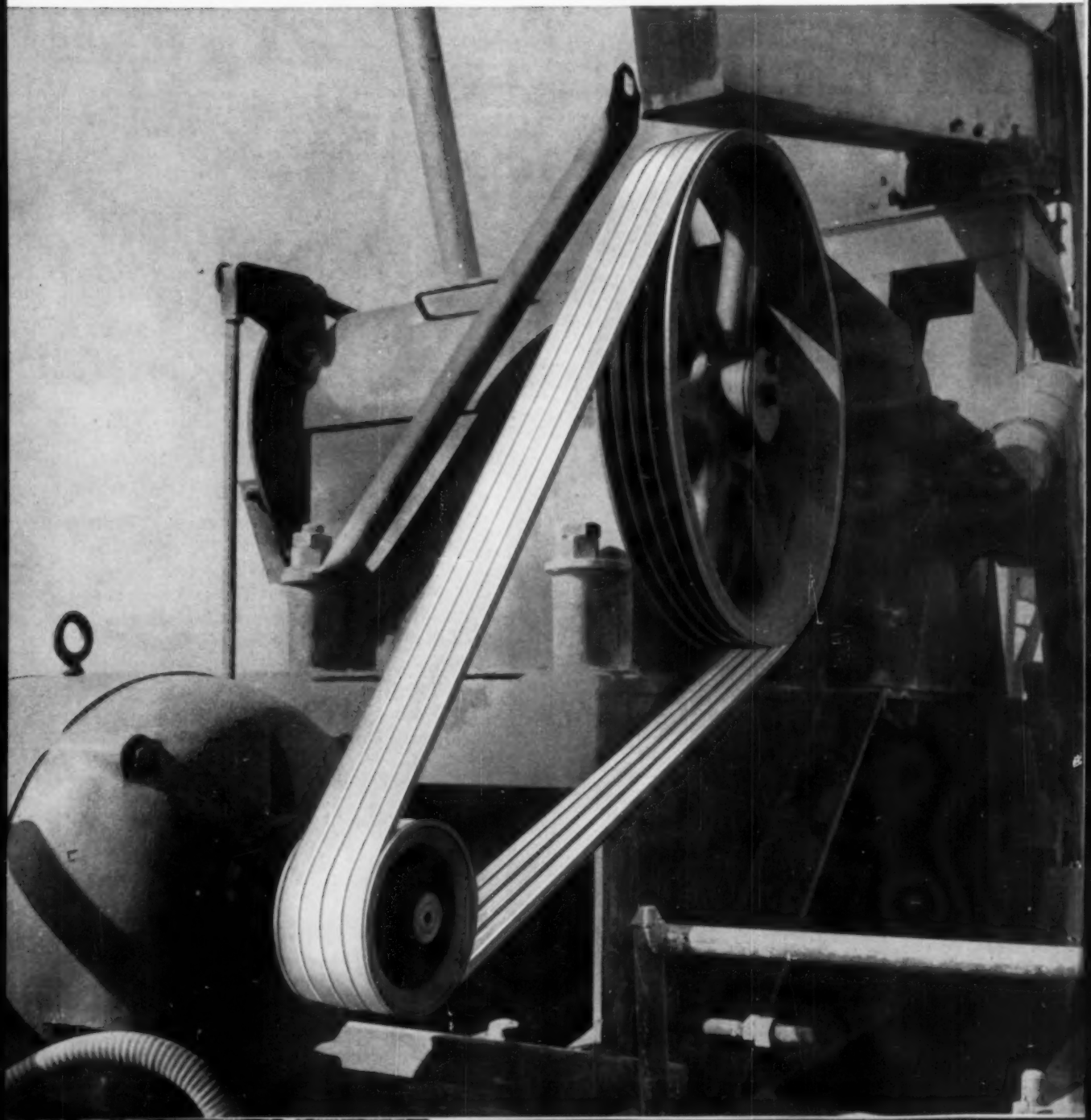


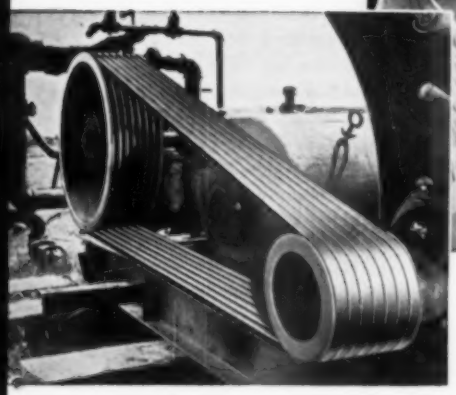
DAYTON V-BELTS

Precision matching divides the load equally . . . guards against overloads and excessive wear

Precision *multi-matching* is an extra Dayton service that doesn't cost one cent more. Yet, it saves you hundreds of dollars in belt and maintenance costs by adding weeks and months of extra life to a set of belts. For *multi-matching* — with the exclusive Dayton Matchometer — insures that each belt is the same length and perfectly mated with every other belt in the entire set.

Actually, every Dayton V-Belt is matched at least three times . . . at the factory, at a regional warehouse, and again before it's delivered to you. Thus, you're always sure that every belt in any set of Dayton Thorobred V-Belts is pulling its proper share of the load without overload or excessive wear.

So, for longer life and reduced costs, insist on *multi-matched* Dayton Thorobreds. Order your next set from your Dayton supplier . . . you'll find him listed at the right.



Every set of Dayton Thorobred V-Belts is *Multi-Matched* on precision Matchometers, the finest device made for matching V-Belts, built exclusively for Dayton Rubber Company.

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Dayton V-Belts Available Through over a Hundred Oil Field Supply Points

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New Orleans—632 S. Peters St.
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Corpus Christi—1920 N. Port Ave.
El Paso—1701 Texas St.
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New Mexico
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Lubbock—Lubbock Electric Co.
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Midland—Electric Motor Service Co.
Odessa—Duke Electric Co.
Pampa—Radcliff Supply Co.
Pearsall—Houston-Oil Field Material Co.
San Antonio—Alamo Iron Works
Wichita Falls—Mims Bearing Co.
Hornsby Heavy Hardware Co.

Wyoming
All Republic Supply Stores

Rocky Mountain API . . .

George Goodin Named District Chairman

George Goodin, Petroleum Information, Casper, Wyoming, was elected chairman of the Rocky Mountain District of the American Petroleum Institute's Division of Production during the group's three-day meeting in Casper.

The meeting attracted some 700 oil men from Rocky Mountain states and Canada.

New Officers

District vice chairmen elected to serve in 1957-58 were as follows: Claude E. Peavy, Britalta Petroleums, Ltd., Calgary, Alberta, Canada, vice chairman for Canada; J. J. Oldham, R. L. Manning Company, Casper, vice chairman for Wyoming; Hugh Palmer, Cardinal Drilling Company, Bismarck, North Dakota, vice chairman for North Dakota; O. L. Odale, Shell Oil Company, Denver, vice chairman for Colorado; L. A. Lindstrom, Ohio Oil Company, Sidney, vice chairman for Nebraska; Auby Rowe Jr., McAlester Fuel Company, Billings, vice chairman for Montana; and Warren L. Taylor, El Paso Natural Gas Company, Salt Lake City, vice chairman for Utah.

Taylor, who also served in 1956-57, was the only officer to be re-elected.

Ernie Howell, Northern Mud Company, Billings, Montana, was elected secretary-treasurer for the next year.

Goodin succeeds Wayne E. Glenn, Continental Oil Company, Denver, as district chairman. Glenn was elected chairman of the District Advisory Committee.

Citations

Three prominent oil men in the Rockies were honored with the API's "Citation For Service" award at the general session.

Recipients of the Citations were: Ralph D. Copley, The California Company (retired), Denver; H. B. Gernert, Trigood Oil Company, and R. L. Armstrong, Oil Well Supply Company, both of Casper.

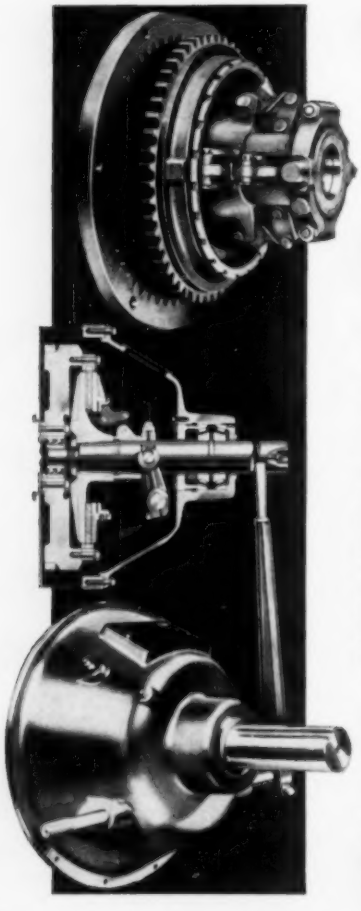
The awards which acknowledge outstanding service to the petroleum industry were presented by D. L. Connelly of Warren Petroleum Corporation, Houston, Texas, who is vice president for production of the API.

Copley was honored "for outstanding service as a member, 1939-41 of the Committee on Standardization of Production Equipment; as a member, 1943-47 of the Committee on Standardization of Wire Rope; and as a member, 1941-47 of the Committee on Standardization of Belting." Copley's award was accepted for him by his son, R. D. Copley Jr., Seaboard Oil Company, Dallas, who flew to Casper especially for the ceremony.

Gernert was honored "for outstanding service as district chairman in 1954-55 and as chairman, District Advisory Committee in 1956-57."

Armstrong was honored "for outstanding service as a member of several district meeting committees and particularly as district secretary-treasurer in 1955-56, and district vice chairman in 1956-57."

ROCKFORD



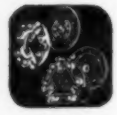
POWER TAKE-OFFS are UNDER RATED

*ROCKFORD POWER TAKE-OFFS are designed for generous overload capacity, when the standard length shaft is used and the center of the load is placed at a point half way along the shaft extension. The proportions of the shaft and bearings are determined by the load capacity of the clutch selected.

Send for This Handy Bulletin

Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

BW



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Martin Cages last much longer. The oil-proof rubber guides do the trick, by absorbing the ball peen hammer action of the hard balls. They also have superior resistance to sand abrasion. And they can be replaced.

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Ball & Seat life is usually doubled, on the average. With the rubber guides, there is much less chattering, chipping and pitting. Ball falls true on seat. Such improvement in Ball & Seat life eliminates a lot of pulling expense.

In the last year alone, new users of Martin Cages have increased by 85%. The word is getting around. More and more economy-minded producers are learning about the advantages of the Martin Cages! . . . Manufactured in open and closed types . . . all diameters and styles. Write for John Martin Catalog No. 4 today. *Martin Cages are available through all supply stores.*

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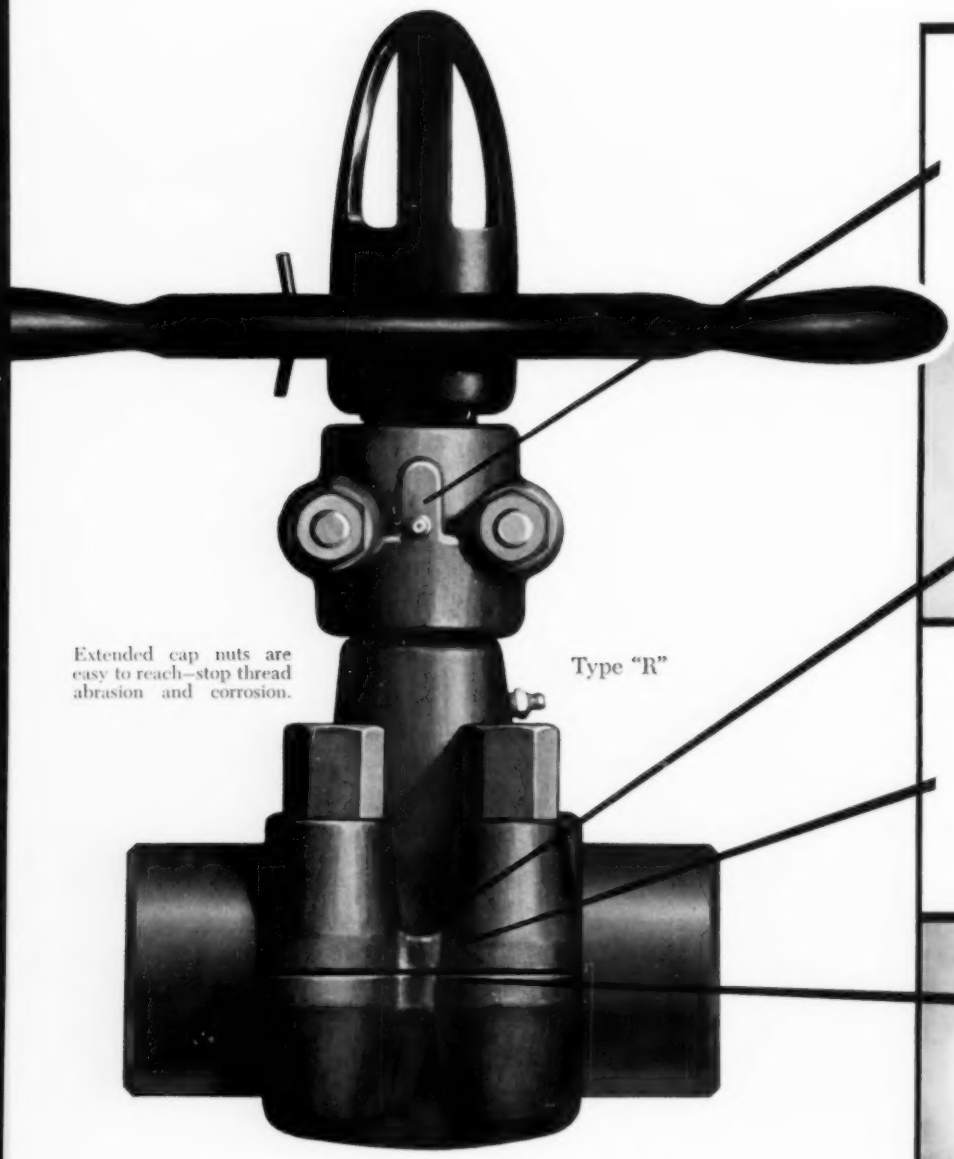


Extended cap nuts are easy to reach—stop thread abrasion and corrosion.

Type "R"

Ball-bearing stem nut on most sizes of the Type "R" affords easier operation — is interchangeable with Type "C" valves, if a Type "R" split bonnet is used.

The oversize carburized steel wear rings are sealed against the subs by "O" rings and are removed straight out with the gate packer as a unit.

Cameron

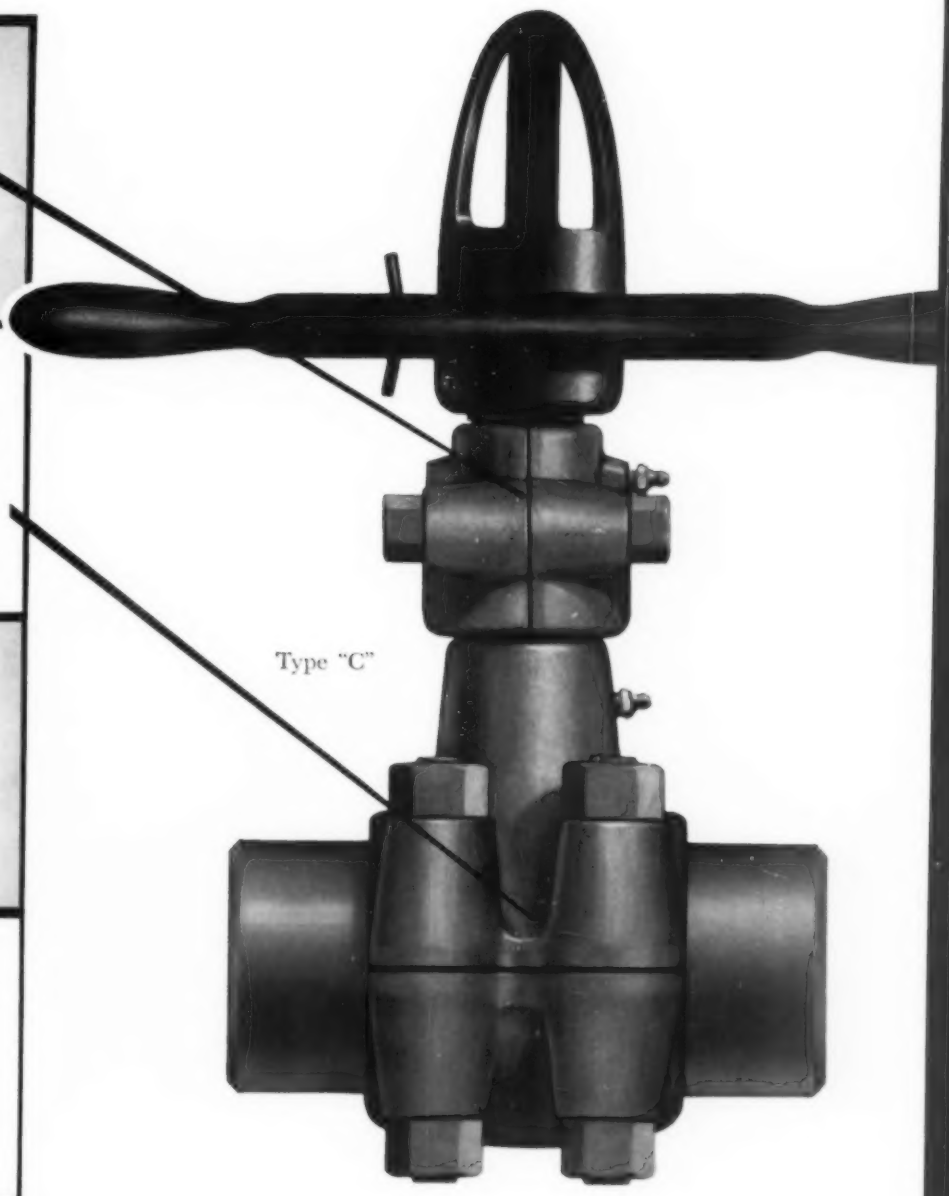
TYPE "R" RUGGED COMPANION TO THE FAMOUS FLEX-SEAL MUD VALVE

For 20 years the famous Cameron Type "C" Flex-Seal Mud Line Valve has been a standard of the drilling industry. Its rugged dependability, low maintenance and economical repair have secured its place on most drilling rigs throughout the oil world.

The increasing use of rigid mud manifolds on drilling barges, unitized power rigs and service trucks for cementing and formation fracturing has indicated the need for a companion valve. The Type "R" meets this need. Subs on the Type "R" are modified to permit the packer and wear rings to be changed as a unit without moving the subs apart as with the Type "C". With this revised construction the Type "R" subs are attached to the cap to form a rigid unit. At the same time, the subs may be changed or swivelled by removing the tack welds and replacing the worn part. The welds are structural only and not subject to pressure. Gates and packers are interchangeable between the Type "C" and the Type "R". The

Tough new compound in the big gate packer means lots more wear — fewer repairs. Replacement requires no special instructions or fixtures — no intricate positioning of gate stem threads.

Integral, welded subs and body cap make misalignment during repairs impossible. If a sub is damaged it may be separated and replaced rather than replacing an expensive body unit.



Type "C"

body and body cap may be interchanged. A ball-bearing nut assembly, standard in most sizes of the Type "R", will also fit the Type "C". Only the wear rings and subs are not interchangeable. The Type "C" may be easily converted to Type "R" by simply substituting subs, packer and wear rings.

Easy-out packer and wear ring means quick repair with no misalignment.

Cameron

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LETOURNEAU Mobile Platforms

make location changes in hours...not days

LeTourneau Offshore Platforms which can make location changes within hours instead of days, are now being delivered in "turn-key" condition within 6 to 9 months from receipt of order — depending on size and design.

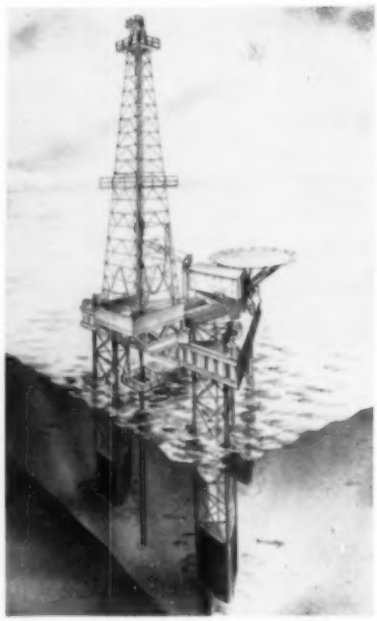
Platforms can be obtained in several types, for workover and completion, as well as for deep drilling. All are modern tripod construction . . . highly mobile and rapidly self-elevating . . . fabricated with matched and proven components manufactured by R. G. LeTourneau, Inc.

The first LeTourneau Platform, christened the "Scorpion" by its purchaser Zapata Offshore Company, has proved outstanding in its ability to make fast location changes, as well as in overall performance.

The "Scorpion" spudded in its first well more than a year ago. Its success has resulted in construction and delivery of a second platform for Zapata, and in orders from a number of other companies for platforms of various types.

A drilling platform to meet your specific operating conditions can now be provided completely rigged and ready for operation. Let our engineers discuss with you your offshore drilling problems, without obligation. All inquiries confidential, of course. Write or call today.

"The SCORPION" now in its second year of service.



FOR DEEPWATER EXPLORATION CO.

LeTourneau is now building this highly versatile mobile platform at Vicksburg, Miss. It is designed with new features that provide ability to: (1) change work locations quickly, (2) skid the entire derrick, drawworks, and substructure off onto a fixed platform for work over operations, (3) complete wells drilled by more expensive units, (4) shift the substructure laterally for servicing multiple wells or final adjustment over drilling location, (5) drill two wells from the same location in water depths up to 70 feet.

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MARINE PRODUCTS DIVISION

2906 South MacArthur Longview, Texas

M-104-R

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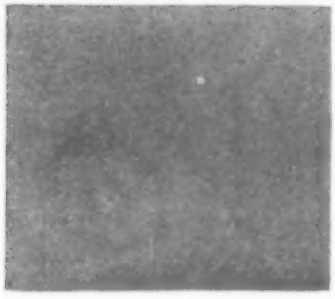
The who, what, and where of U.S. offshore drilling — listing contractor, operator, location, water depth, type unit, and rig specifications

The Petroleum Engineer's exclusive . . .

OFFSHORE RIG LOCATOR



WHILE total drilling activity in the U. S. is at a low ebb, the number of rigs in operation in the offshore areas is steady, and in Louisiana has shown a slight gain. This feature is another of **The Petroleum Engineer's** pioneering editorials to provide the answers of who is drilling for what operator and with what type of equipment, and where. This effort is a logical followup of PE's highly successful and popular **RIG LOCATOR** covering all U. S. and Canadian contractor rigs.

As in any initial project such as this, it would be fool hardy to expect that all details on every offshore drilling operation could be included. Although this first **"Offshore Rig Locator"** is a "new born" editorial child, it does include a large majority of the U. S. offshore drilling operations. It is fully expected that future directories of this nature will, in a short time, contain practically all U. S. offshore drilling rigs.

Your editors, with some experience in planning and executing drilling rig directories, investigated and surveyed to determine just what information was most desirable and valuable. Those items shown below proved to be the key listings which, in brief, give the highlights of who, what, and where in offshore drilling. It is our sincere hope that this new feature proves of sufficient value to our readers that we can include it as a special section in our regular **RIG LOCATOR** directories published three times a year.

Acknowledgments. Admittedly, it is an impractical task to expect any one source to compile this mass of data and assemble it into usable and logical form. The editorial staff wishes to acknowledge with sincere appreciation the generous help given by Reed Roller Bit Company of Houston, Texas, to the several offshore drilling contractors, and to a number of offshore operators for providing the essential data necessary for this compilation.

Your comments on this new feature are cordially invited. Just address your letter to the RIG LOCATOR Editor, *The Petroleum Engineer*, P. O. Box 1589, Dallas 21, Texas.

Some abbreviations. Like any compact directory, a number of popular and recognized abbreviations were used. Many, of course, are obvious, others less obvious. Where there might be some doubt, here are a list of abbreviations used:

Operators

Std of Cal — Standard Oil Company of California.
Gen Pet — General Petroleum Corporation.
Std Texas — Standard Oil Company of Texas.
Texaco — The Texas Company.
Ark Fuel — Arkansas Fuel Oil Corporation.
Calif Co — The California Company.
Kermac — Kerr-McGee Oil Industries, Inc.
Pan Am — Pan American Petroleum Corporation.
CATC — Continental Oil Company, The Atlantic Refining Company, Tidewater Oil Company, and Cities Service Oil Company.
M-C-N — Magnolia Petroleum Company, Continental Oil Company and Newmont Oil Company.

Manufacturers

Natl — The National Supply Company.
Beth — Bethlehem Supply Company.
"Oilwell" — Oilwell Supply, Division of U. S. Steel Corporation.
Brwstr — The Brewster Company, Inc.
Emsco — Continental-Emsco Company.
Ideco — Ideco, Inc.
Wilson — Wilson Manufacturing Company, Inc.
U — Unit Rig & Equipment Company.

Others

dsl engine — diesel engine.
dsl-elec — diesel-electric

CALIFORNIA

Owner's Name, Address	Rig, Barge Name or Number	Operator Drlg For	Offshore Location—(County)	Water Depth Ft	Type Rig Power	Drwwks Make & Model	Total hp Available to Drwwks	Total hp to all Main Mud Pumps	Rated Drlg Depth with 4½" Pipe
Brown Drlg Co. 1456 E. Hill Long Beach, Calif.	—	Monterey-Texaco	Orange, Seal Beach	40	dsl engine	Natl 50-A	750	750	8000
Humble Oil & Ref. Co. 612 S. Flower Los Angeles, Calif.	Rig 52 SM-1	Humble	Santa Barbara	220	dsl engine	Hopper	300	175	3500
Marex, Inc. 112-½ Del Laquara St. Santa Barbara, Calif.	PCS "Exploit"	Texaco	Santa Barbara	110	dsl engine	Howard & Turner	175	175	1500
	"Labusca"	Western Gulf	Santa Barbara	120	dsl engine	Howard & Turner	165	165	1500
	"Sandab V"	Tidewater	Santa Barbara	150	dsl engine	Howard & Turner	175	75	1500
Richfield Oil Corp. 529 E. Gutierrez Santa Barbara, Calif.	"La Ciencia"		Santa Barbara	140	dsl engine	Hopper Hoist	165	165	1500
	"Rincon"		Santa Barbara	250	dsl engine	Emsco 160	400	300	4000
Standard Oil of Cal. 225 Bush St. San Francisco, Calif.	"Western Explorer"	Std. of Cal.	Santa Barbara	220	dsl engine	Hopper Hoist	200	200	3500
Sun-Marine Drlg. Corp. (Offshore Constr., Inc.) 417 S. Hill St. Los Angeles, Calif.	"Pacific Driller No. 1"	Std. of Cal.	Santa Barbara	80	dsl engine	Natl 110	1500	2500	16,000
General Petroleum Co. 612 S. Flower, Los Angeles, Calif.	"Torrey"	Gen. Pet.	Santa Barbara	300	dsl engine	Wagner-Morehouse D15-T 4-B	300	450	4500

TEXAS

PLATFORM-TENDER DRILLING UNITS

Kerr-McGee Oil Ind. Kerr-McGee Bldg. Oklahoma City, Okla.	Bge 16 "Kermac 1"	Std. Texas	Mustang Is. Area	42	dsl engine	Natl 100	900	900	10,500
Salt Dome Prod. Co. 737 Tex. Natl. Bank Bldg. Houston, Tex.	Rig 10 "Pelican"	Gulf	Mustang Is. Area	55	dsl engine	Beth 1013	1500	1500	28,000

SELF-CONTAINED PLATFORMS

Brewster-Bartle Drlg. Inc. Bank of the SW Bldg. Houston, Tex.	Rig 3-A	Gulf	Mustang Is. Area Blk 889	50	dsl engine	"Oilwell" 96	1200	1200	15,000
C. G. Glasscock 1601 Wilson Tower Corpus Christi, Tex.	Rig 1	Ark. Fuel	Mustang Is. Area	39	dsl engine	Natl 130	1200	1520	16,000

LOUISIANA

MOBILE DRILLING BARGES

Coral Drlg Co. 6100 Camp Bowie Ft. Worth, Tex.	"Mr Arthur"	Calif. Co.	Main Pass Area Blk 45	30	dsl-elec	Brwstr NE-12	1250	2500	20,000
Kerr-McGee Oil Ind. Kerr-McGee Bldg. Oklahoma City, Okla.	Rig 40	Kermac-Phillips-Pan Am	Ship Shoal Area Blk 31	18	dsl engine	Emsco J-1600	1150	1250	16,000
	Rig 44	Kermac	Main Pass Area Blk 52	20	dsl engine	Ideco 1350-S	1550	1760	20,000
	Rig 45	CATC	West Delta Area Blk 84	35	dsl engine	"Oilwell" 96-S	1150	1100	16,000
	Rig 46	CATC	Vermilion Area Blk 95	30	dsl-elec	Emsco EDA 4-60	1250	1250	20,000
	Rig 47	Phillips	Eugene Is. Area Blk 129-A	50	dsl-elec	Emsco EDA 4-60	1250	1250	20,000
Morris & Hamilton 1521 Commerce Houston, Tex.	"Carter Mart"	Texaco	S. Timbalier Area Blk 11	40	dsl engine	Wilson 66	2400	2800	25,000
Ocean Drlg & Expl. 918 Carondelet Bldg. New Orleans, La.	"Mr. Charlie"	Shell	E. Cameron Area Blk 17	40	dsl-elec	Emsco EDA	1500	1000	20,000
	"John Hayward"	Texaco		30	dsl-elec	Emsco ECA	1200	1000	15,000
	"Margaret"	Shell	W. Cameron Area Blk 249	65	dsl-elec	Emsco EDES	1500	1000	20,000
	"St. Louis"	Shell	South Pass Area Blk 27	30	dsl-elec	Emsco ECB	1200	1000	15,000
The Offshore Co. Box 1908-1268 Baton Rouge, La.	Rig 53	Humble	Eugene Is. Area Blk 77	26	dsl-elec	Natl 130-E	1860	1860	20,000
	Rig 54	Shell	Vermilion Area Blk 164	100	dsl-elec	Natl 130-E	2625	2000	20,000
	Rig 55	Calif. Co.	West Delta Area Blk 29	38	dsl-elec	Natl 130-E	2625	2000	20,000

Here the Brent Company's HD-16 torque converter tractor moves mud out of a sump. Says operator Joe Myers, "I say this A-C crawler tractor can't be beat. The '16 will take right off in third gear. On this work, a tractor needs constant power and speed to stop the mud from draining back into the sump. The '16's got both."

"BEATS 'EM ALL IN SOFT MUD,"

—says oil field superintendent

D. T. Phillips, superintendent for Brent Construction Co., Ltd., Estewan, Saskatchewan, states:

"For working in drilling mud on sump jobs, we find the Allis-Chalmers HD-16 can operate in a lot softer mud than any other crawler tractor.

"First we bought an Allis-Chalmers HD-15 and on the basis of this machine's fine performance, we got a '16. We find it's an excellent crawler for sump work, winch work and for moving mud.

"After drilling operations, the HD-16 moves into the sump and spreads the mud out evenly to dry, then fills the hole with dry earth. On an average sump 5 ft. x 75 ft., we can slope the mud, fill the hole and renovate a four-acre section in about seven hours with our HD-16."

Find out how Allis-Chalmers crawler tractors can speed your oil field jobs. Your nearby dealer can tell you how Allis-Chalmers exclusive advantages mean better performance. Allis-Chalmers, Construction Machinery Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS ***Engineering in Action***

LOUISIANA – (Continued)

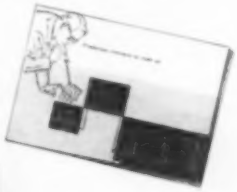
Owner's Name, Address	Rig, Barge Name or Number	Operator Drlg For	Location—Designation	Water Depth Ft	Type Rig Power	Drwwks Make & Model	Total hp Available to Drwwks	Total hp to all Main Mud Pumps	Rated Drlg Depth with 4½" Pipe
Rowan Drlg. Co., Inc. Drawer 12247 Ft. Worth, Tex.	Bge 19	CATC	Bay Marchand Blk 1	10	dsl-elec	U-1220-E	2250	2100	20,000
Shell Oil Co. Box 193 New Orleans, La.	Marine Rig 10	Shell	Eugene Is. Area Blk 18	25	dsl engine	Natl 125	1200	1200	12,500
Southeastern Drlg. Corp. 901 Employers Ins. Bldg. Dallas, Tex.	Rig 22-Bge 8	Calif. Co.	South Pass Area Blk 29	45	dsl engine	Natl	2200	1550	18,000
Zapata Off-Shore Co. 2218 1st City Natl Bank Bldg. Houston, Tex.	Rig 2 "Scorpion"	Calif. Co.	Main Pass Area Blk 58	62	dsl engine	"Oilwell" 96	1850	1850	15,000
	Rig 3 "Vinegarroon"	Sun	W. Cameron Area Blk 67	32	dsl engine	"Oilwell" 96	2000	2000	15,000
PLATFORM-TENDER DRILLING UNITS									
Deepwater Expl Co. 1109 Tex. Natl. Bk. Bldg. Houston, Tex.	"Deepwater" No. 2	Humble	Grand Isle Area Blk 28	45	dsl-elec	Natl 130-E	1500	1000	16,000
Delta Marine Drlg. Box 2012 Tyler, Tex.	"Joseph Zeppa"	M-C-N	W. Cameron Area Blk 111	42	dsl-elec	Emsco JB-1250	1600	1600	15,000
Dixilyn Drlg Corp. Box 3427 Odessa, Tex.	Rig 6 "Murmanill I"	Phillips-Gulf	S. Timbalier Area Blk 21	35	dsl engine	Natl 130	1500	1500	20,000
Hawkins-Wilkins Prod. Co. 373 San Jacinto Bldg. Houston, Tex.	Humble ST-2	Humble	West Delta Area Blk 30	56	dsl engine	Ideco PR-1050	1050	1200	15,000
Kerr-McGee Oil Ind. Kerr-McGee Bldg. Oklahoma City, Okla.	Rig 39 & "Frank Phillips"	Humble	West Delta Area Blk 24	20	dsl engine	Natl 125	1800	1200	16,000
	Rig 43 & Kermac II	CATC	Grand Isle Area Blk 29	65	dsl engine	Emsco J-1000	1350	1730	14,000
	Rig 48 & Kermac III	CATC	Vermilion Area Blk 120	68	dsl-elec	Emsco EDA-4-60	2625	2625	16,000
Llano Drlg Co. 301 V & J Tower Midland, Tex.	Rig 6 "Clayton G. Dorn"	Forest	Ship Shoal Area Blk 149	55	dsl- engine	"Oilwell" 96	1800	2575	20,000
Loffland Bros. Box 1649 Tulsa, Okla.	Rig 127 "R. W. McIlvain"	Pure	E. Cameron Area Blk 126	70	dsl engine	Natl 125	1525	1765	18,000
	Rig 130 S-26	Calif. Co.	Bay Marchand Ar.	43	dsl engine	U-30	1200	1800	15,500
	Rig 1 & Rig 148 S-24	Calif. Co.	West Delta Area Blk 30	39	dsl engine	Natl 125	1500	1850	18,000
	Rig 133	Calif. Co.	Main Pass Area Blk 41	45	dsl engine	U-30	1200	1800	15,500
	Rig 149	CATC	S. Timbalier Bay Blk 23	40	dsl engine	U-1220	1500	1500	20,000
Magnolia Pet. Co. Dallas, Tex.	"Gulf Coast Bge 2"	Magnolia	W. Cameron Area Blk 17	20	dsl-elec	Natl	1250	3500	16,000
Magnolia-Continental-Newmont Morgan City, La.	Rig 34 Bge 1	M-C-N	Ship Shoal Area Blk 72	25	dsl engine	Natl 125	1040	1040	15,000
	Rig 39 Bge 2	M-C-N	Eugene Is. Area Blk 129	52	dsl engine	Natl 125	1240	1300	15,000
	Rig 44 Bge 5	M-C-N	Vermilion Area Blk 46	20	dsl engine	Emsco JB-1250	1040	1040	15,000
	Rig 45 Bge 6	M-C-N	Eugene Is. Area Blk 125	40	dsl engine	Natl 125	1040	1080	15,000
	Rig 47 Bge 3	M-C-N	Ship Shoal Area Blk 113	52	dsl engine	Natl 125	1040	1040	15,000
	Rig 48 Bge 4	M-C-N	E. Cameron Area Blk 64	50	dsl engine	Emsco JB-1250	1040	1040	16,000
	Rig 57 Bge 7	M-C-N	Eugene Is. Area Blk 94	35	dsl engine	Natl 130	1040	1040	16,000
Penrod Drlg Co. 418 Market St. Shreveport, La.	Rig 10 "Eagle"	Gulf	S. Timbalier Bay Blk 128	40	dsl engine	Natl 130	1500	1520	18,000
Reading & Bates Offshore Drlg Co. 1502 Philtower Tulsa 3, Okla.	"J. W. Bates"	CATC	E. Cameron Area Blk 71	60	dsl engine	Natl 130	2000	3000	20,000
	"George M. Reading"	CATC	Vermilion Area Blk 102	60	dsl engine	Natl 130	2000	3000	20,000+
Rowan Drlg Co., Inc. Drawer 12247 Ft. Worth, Tex.	Rig 17	CATC	E. Cameron Area Blk 67	35	dsl engine	Natl 125	1305	2100	15,000
	Rig 30	Humble	Grand Isle Area Blk 18	50	dsl engine	Emsco A-1500	1500		18,000
Southeastern Drlg Corp. 901 Employers Ins. Bldg. Dallas, Tex.	Rig 12 Bge 9	CATC	West Delta Area Blk 57	—	dsl engine	"Oilwell" 96	1100	2250	16,000
Zapata Off-Shore Company 2218 First City Natl Bank Bldg. Houston, Tex.	"Nola No. 1"	M-C-N	Eugene Is. Area Blk 89	16	dsl engine	Natl 125	1350	900	15,000

Service and thoroughness cut your dehydration costs

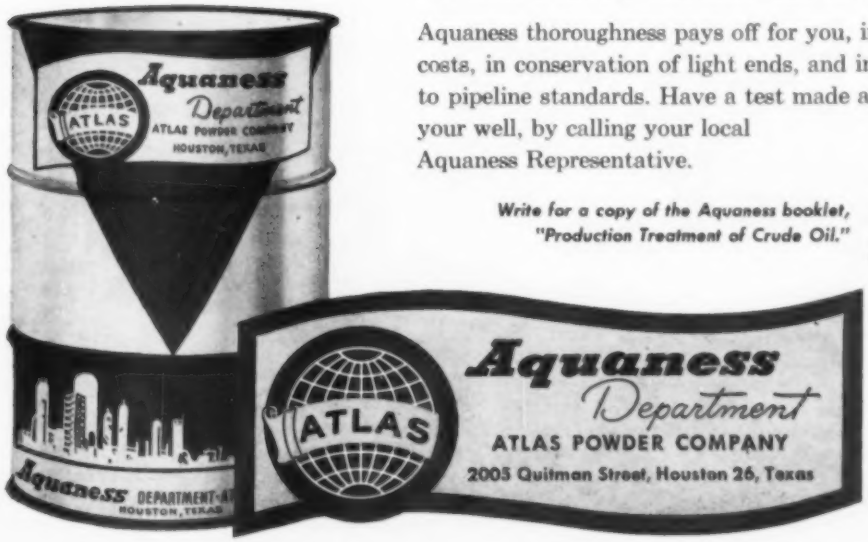
Breaking crude oil emulsions can cost less, when you're using the right *emulsifier* in the right *way*.

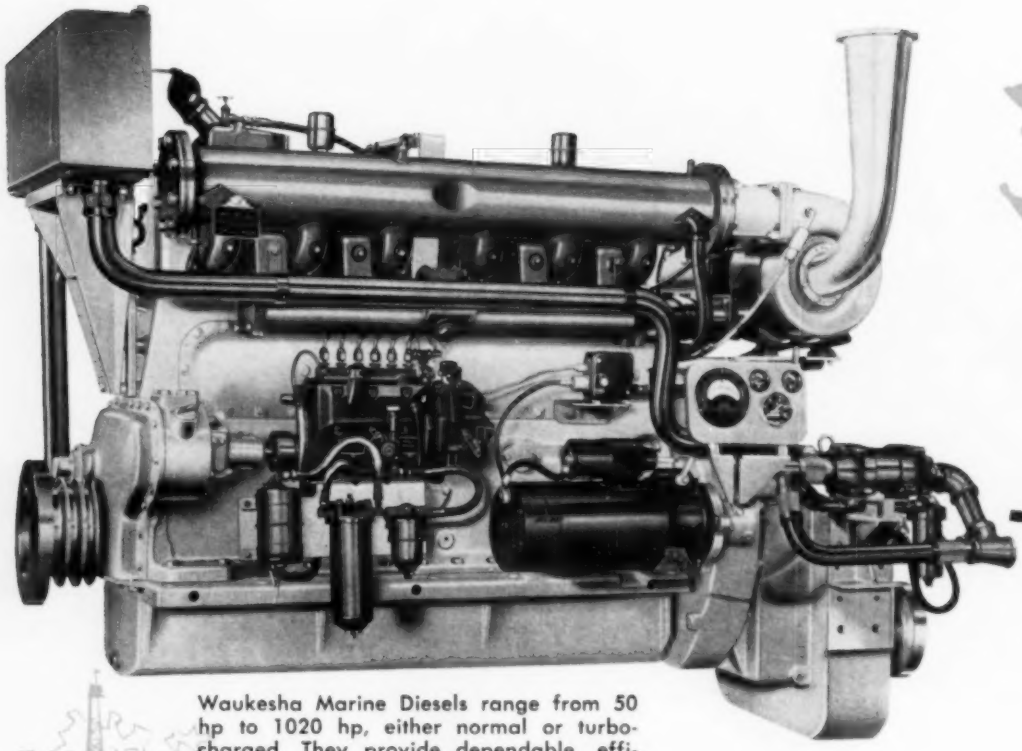
It takes a lot of experience and a lot of testing to find the best way to demulsify and the best chemicals to do the job. That's why Aquaness field men check and re-check, until they come up with the best demulsifier answer to your specific problem. They're not satisfied until they find the most effective and economical Aquaness demulsifier for your emulsion.

Aquaness thoroughness pays off for you, in lower chemical costs, in conservation of light ends, and in consistent adherence to pipeline standards. Have a test made at your well, by calling your local Aquaness Representative.

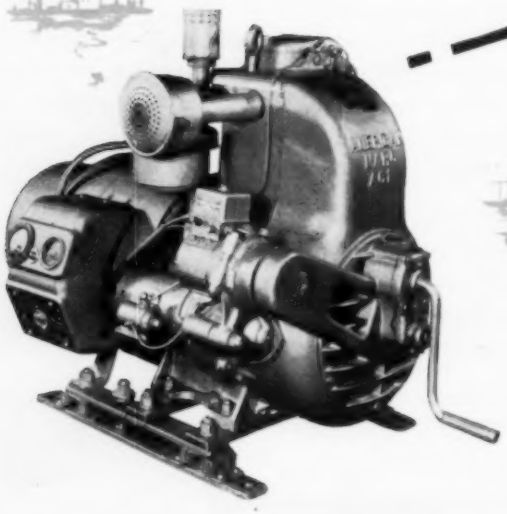


Write for a copy of the Aquaness booklet, "Production Treatment of Crude Oil."

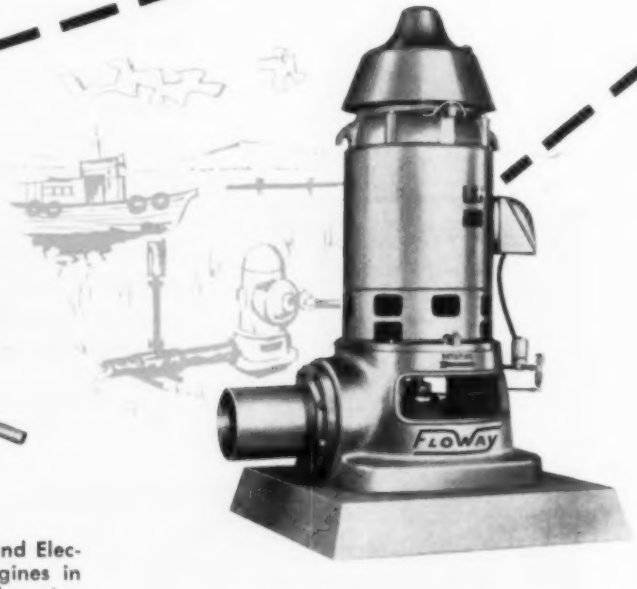




Waukesha Marine Diesels range from 50 hp to 1020 hp, either normal or turbo-charged. They provide dependable, efficient power for crewboats and towboats in the roughest industrial service. Waukesha Marine Diesels set a new standard for safety, simplicity, smoothness and economy.



American M.A.R.C. Diesel Power Units and Electric Plants were the first air cooled engines in the U.S.A. and are leaders in the small engine field. The low maintenance cost and operating economy of American M.A.R.C. Air Cooled Diesel Engines make them ideal power plants wherever a 5-15 hp requirement exists.



FloWay Turbine Pumps are excellent for a wide variety of water applications. Basic design features and improvements over conventional pump design result in maximum efficiency and trouble free operation. FloWay Pumps are especially suited for agricultural and industrial application.

important new additions to the complete equipment line of

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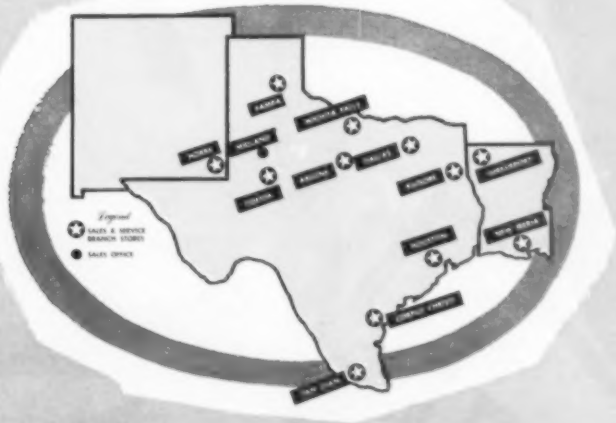
AMERICAN M·A·R·C DIESEL ENGINES

FLOWAY TURBINE PUMPS

Waukesha Sales & Service, Inc., supplies dependable power for every need: drilling, pumping, hoisting, lighting, transportation.

In addition to a full line of Waukesha Drilling Engines, Kohler Power Units and many other name brands, Waukesha Sales & Service, Inc. now announces the addition of three important products—a marine diesel engine, a small air or liquid cooled diesel engine and a turbine water pump—described on the opposite page. These products are among the finest in their fields.

Write for full information and service locations.



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EXCLUSIVE DISTRIBUTORS FOR WAUKESHA PRODUCTS IN TEXAS, NORTH AND WESTERN LOUISIANA, SOUTHERN ARKANSAS AND NEW MEXICO

WORLD'S LARGEST DISTRIBUTOR OF OIL FIELD ENGINES

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FLUID PACKED
MULTIPLE TUBE PUMPS*

For over a third of a century the FLUID PACKED MULTIPLE TUBE *has been the pump specified wherever sand or abrasion created pumping problems.*

The long annulus between the carefully fitted telescopic tubes acquires its fluid packing from the production of the well itself and generates its own turbulent seal from the reciprocating motion of the tubes. The unique design permits a loose fit, greatly increasing the ability of the pump to tolerate quantities of sand, but maintaining the efficiency of the pump because of the long turbulent seal.

Other Three-Tube Pumps are now available, but only the FLUID PACKED MULTIPLE TUBE offers the benefits of a third of a century of manufacturing know-how, plus the support of the finest service organization in the oil fields today.

Make certain that you won't be the angry man. Buy the Fluid Packed Multiple Tube— THE PUMP THAT SETS THE STANDARDS BY WHICH OTHER PUMPS ARE JUDGED.

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Product

LOUISIANA – (Continued)

INLAND BARGE — PLATFORM

Owner's Name, Address	Rig, Barge Name or Number	Operator Drlg For	Location Designation	Water Depth Ft	Type Rig Power	Drwwks Make & Model	Total hp Available to Drwwks	Total hp to all Main Mud Pumps	Rated Drlg Depth with 4½" Pipe
Magnolia Pet. Co. Dallas, Tex.	Rig 52 "Gulf Coast Bge 1"	Magnolia	Main Pass Area Blk 46	25	dsl engine	Natl 125	1560	1560	15,000

SELF-CONTAINED PLATFORMS

Brewster-Bartle Drlg Co. Bank of the SW Bldg. Houston, Tex.	Rig 1-A	CATC	—	50	dsl engine	"Oilwell" 96	3300	3300	20,000
Dixilyn Drlg Corp. Box 3427 Odessa, Tex.	Rig 7	Gulf	Ship Shoal Area Blk 154	52	dsl engine	—	2400	2400	20,000
Loffland Bros. Box 1649 Tulsa, Okla.	Rig 46	CATC	Grand Isle Area Blk 47	95	dsl-elec	Natl 34-10	2840	1550	20,000
	Rig 62	CATC	Grand Isle Area Blk 47	95	dsl-elec	Natl 34-10	1500	1600	20,000
	Rig 125	Phillips	Eugene Is. Area Blk 129-A	52	dsl-elec	Natl 34-10	1600	1050	20,000
	Rig 144	Shell	Eugene Is. Area Blk 128-A	48	dsl engine	U-30	1500	1500	18,000
Magnolia-Continental-Newmont Morgan City, La.	Rig 59	M-C-N	Eugene Is. Area Blk 119	38	dsl engine	Natl 55	920	920	7500
The Offshore Co. Box 1908-1268 Baton Rouge, La.	Rig 7	—	Eugene Is. Area	60	dsl-elec	Natl U-34-10FE	1700	1700	20,500
	Rig 21	—	E. Cameron Area	70	dsl-elec	Natl U-34-10FE	1700	1700	20,000
	Rig 24	Shell	Eugene Is. Area Blk 116	50	dsl-elec	Natl 130-E	1700	1700	20,000
The Power Rig Drlg Co. Box 1436 OCS Lafayette, La.	Platform No. 9	Magnolia	Eugene Is. Area Blk 89	30	dsl engine	U-15	750	1000	11,000
Rimrock-Tidelands 1315 Gravier St. New Orleans, La.	"Rimrock I"	Sinclair	Eugene Is. Area Blk 175	87	dsl engine	Beth MC950	1200	1200	18,000
	"Rimrock III"	Sinclair	S. Timbalier Area Blk 86	90	dsl-elec	Brwstr N12A	1400	1800	18,000
Rowan Drlg Co., Inc. Drawer 12247 Ft. Worth, Tex.	Rig 8	Humble	Grand Isle Area Blk 18	50	dsl engine	Natl 125	2340	1920	18,000
	Rig 11	CATC	Grand Isle Area Blk 47	75	dsl engine	U-1220	2400	2250	20,000
Salt Dome Prod. Co. 737 Tex. Natl Bank Bldg. Houston, Tex.	Rig 12	Gulf	Ship Shoal Area Blk 154	60	dsl engine	Beth Tornado	900	1350	14,000
Shoreline Drlg Co. 1203 Beck Bldg. Shreveport, La.	Rig 3	CATC	West Delta Area Blk 58	30	dsl engine	U-1220	2400	2400	20,000
	Rig 7	CATC	West Delta Area Blk 59	30	dsl engine	U-1220	2400	2400	20,000
Southeastern Drlg Corp. 901 Employers Ins. Bldg. Dallas, Tex.	Rig 7	M-C-N	Eugene Is. Area Blk 128	52	dsl engine	"Oilwell" 96	1560	1040	14,000
	Rig 23	M-C-N	Eugene Is. Area Blk 126	38	dsl engine	"Oilwell" 96	1560	1560	14,000
	Rig 25	M-C-N	Eugene Is. Area Blk 128	52	dsl engine	Natl 130	1560	1040	16,000

250 Attend Continental-Emsco's First Sales Meeting

Continental-Emsco recently held its first company-wide sales meeting following the first of the year consolidation. The three-day meeting was held at Dallas headquarters.

Over 250 members of the organization attended from the United States, Canada and South America. Continental-Emsco is a division of The Youngstown Sheet and Tube Company and was formed when the parent company consolidated Continental Supply Company and Emsco Manufacturing Company on January 1.

Shown at the first annual banquet, following consolidation of Emsco and Continental, are, from the left: W. T. Powell, executive vice president, manufacturing and engineering, Continental-Emsco; J. L. Mauthe, chairman of the board, The Youngstown Sheet and Tube Company; F. I. Brinegar, executive vice president, distribution, Continental-Emsco; F. M. Mayer, president of Continental-Emsco; W. J. Morris, retired chairman of the board, Continental-Emsco; and Walter E. Watson, vice chairman of the board, The Youngstown Sheet and Tube Company.

SLIM HOLES TO 5100 FEET WITH THE *Joy* 510

Get the complete story on this modern slim hole rig . . . write for Bulletin 154-B3

HERE'S A RIG DESIGNED FOR SLIM HOLE WORK—either deep exploration or slim hole production. It's completely portable, mounted on a single trailer for fast rig-up and tear-down . . . lightweight, yet has all the rugged features of the largest rigs: LARGE ROTARY TABLE OPENING with standard API taper . . . AIR CLUTCHES for sensitive control of hoisting drums and rotary drive . . . TORQUE CONVERTER for infinitely variable speed and torque multiplication. Find out more about the economies of operating this true slim hole rig . . . write to ***Joy Manufacturing Company, Oil Field Drill Division, P.O. Box 35326, Airlawn Station, Dallas 35, Texas.*** In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*

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P 422.91

A landman looks at the industry's

ADVENTURE at Sea

A story of the oilman turned seadog — complete with plot and sub-plots, villains, pathos, suspense, a little fantasy and lots of tear-jerking . . . Only the last chapter is yet to be written

Howard A. McKinley
Regional Land Superintendent
Continental Oil Company, Houston, Texas

IN an industry like ours born of and sustained by exploration, adventure — the daring enterprise — seems to be merely one of the integral parts of the whole. But to all but the jaded, the adventurous element is its fascination, the stimulus which goads us to greater efforts. We are apt to become oversophisticated at times, but happily, not for long.

When we begin to feel "we've seen it all," an operation like the one underway in the Gulf of Mexico jars us back to a more natural state: Here is an adventure of monumental proportions, this adventure at sea.

There is an air of simplicity about the offshore which is deceptive. To believe it so is understandable. But the story of the industry's efforts in the Gulf reveals quite a different picture, one of bewildering complexity. Problems, both man-made and natural, abound. In many ways, it is a rather treacherous sea upon which we have embarked.

In reviewing the history of any operation, the reasons that gave impetus to it are worth noting. Not all adventures are undertaken just because the spirit moves — certainly not one of this magnitude.

Buried Treasure

Perhaps the most important factor in the move offshore was the belief on the part of many geologists and geophysicists that beneath the veneer of water lay an extension of what they had uncovered onshore. The most prospective area, being off the coasts of Louisiana and Texas, embraced 27,000 square miles, even if you confined it to waters no deeper than 120 ft — an area 70 percent as large as the adjacent onshore area or, to put it another way, an area embracing 40 percent of a producing province. If the scientific reasoning was correct, and the area was as good as the bait, then a big one was not under lease.

While the temptation was great (and doubtless a difficult one to deny), the time was not right until 1944. To be sure, the Gulf had been probed before then. Creole was discovered in 1938. But confronted by low product prices, success onshore and the difficulties of the war period, the industry was not inclined to rush offshore during the late thirties and early forties. Circumstances, in certain ways, had changed by 1944.

Offshore Overtures

Statistics on performance have a way of inciting renewed efforts. When the API reported that withdrawals in 1943 exceeded the amount of new oil discovered during the year, the familiar cry, "we are running out of oil," was heard again. A discovery rate which had declined steadily from 1937 seemed to lend added weight to the wailings of the "crepe hangers." Renewed efforts were obviously necessary if the critics and their fellow travelers were to be silenced. And when, in August of 1944, a seismograph appeared off Louisiana, the trek to the sea had begun in earnest. A new era was opening.

The exploratory or geophysical phase was quick to gather momentum. Technical difficulties were overcome with increasing experience, and costs per mile of traverse declined sharply to a point considerably below comparable costs onshore. If an operator wished to seismograph the Louisiana-Texas off-

Presented as an address before the American Association of Petroleum Landmen at San Antonio, Texas, April 26, 1957, and published here by special permission.

shore area to a water depth of 120 ft, his estimated cost would be approximately $15 million. A significant sum of money. But when it is further estimated that his chances of uncovering 100 or more unleased structures of prime quality are great, the price is hardly excessive. Finding a single structure onshore of comparable quality would probably require an expenditure in excess of $1 million. Therefore, a finding rate of $150,000 is hardly exorbitant. And since the finding rate in the early days was not much over $75,000, the rapid movement seaward is certainly explicable.

By 1950, the year of the Supreme Court decision, as many as thirty-seven crews roamed the waters of the Gulf. With the passage of the so-called Tidelands Acts in 1953, following the three year "shut down" period, the level of geophysical activity again climbed upward. By the end of 1956, the industry had logged in excess of 12,000 crew weeks offshore.

Since the beginning of the fourth quarter of 1956, the number of crews operating offshore has dropped dramatically. Most of the needed reconnaissance work has obviously been completed. Indeed, the majority of the crews are now employed in detail work or other specialized projects such as refraction work on leased prospects. But there is real significance in what the remaining crews are doing. The area between 120 and 600 ft, the edge of the Shelf, has claimed their attention. Since the deepest water drilled to date is 112 ft, there apparently exists little doubt in the minds of some that the problems of drilling in even deeper water can be overcome. There is this added attraction. If the hunting grounds can be expanded to encompass the area out to 600 ft, 50,000 square miles, not 27,000, will be available to the bit off Louisiana and Texas — an area somewhat larger than the State of Louisiana.

A Sale! A Sale!

The verdict of the seismograph was a complete confirmation of the theoretical hypotheses advanced by the explorers. Prospects for oil and gas offshore certainly compared with the prospects onshore. And the logical follow-up to the launching of the geophysical program in 1944 — a lease sale — was not long in coming. In August 1945, the first "true" offshore sale was staged by Louisiana. At an average price per acre of $5.12, Magnolia purchased leases on approximately 129,000 acres. A low price indeed, when compared with the prices of today. Louisiana conducted, subsequently, eleven more sales at which the average per acre price

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of artificially producing wells from 10,000 feet or deeper? *Consult your nearest Merla representative* for details on single well, closed rotative compressor systems. You will be surprised at the economics of this type operation.

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A special, heavy-duty "A" frame permits capacity loads with extended boom at long radius. The famous UNIT sealed cast gear case serves as a protection against salt spray.

SAFETY is a major feature. Incorporated in the Mariner design, are positive and mechanical boom stops. These boom stops control the angle of elevation and prevent the boom from whipping back. Also the safety-promoting Full Vision Cab enables the operator to see what he is doing at all times. Load ratings are based on high factors of safety.

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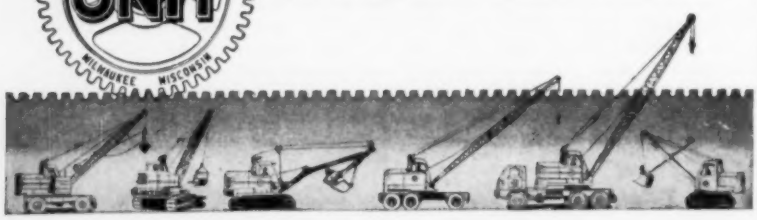

never exceeded $31, leasing about 2.25 million acres. In 1947, the State of Texas auctioned off almost 330,000 acres at a price of $19 per acre. This was the only major sale held at Austin prior to 1953. When the United States Attorney General filed, on December 21, 1948, a motion in the U. S. Supreme Court for leave to file original complaints against Louisiana and Texas, leasing came to a halt. Not until 1953 did leasing begin again.

When the Submerged Lands and the Outer Continental Shelf Lands Acts were passed in May and August of 1953, the door was open once more. But the admittance fee had inflated grossly during the intervening five years. Where $12 per acre would get you a good seat in 1948, $260 per acre — average — was needed now. There have been 28 sales, state and federal, of Gulf acreage since 1953, involving slightly more than 1.5 million acres, approximately 690,000 off Texas and 820,000 seaward of Louisiana. The difference between acreage costs before 1949 and after 1953 is staggering.

At the 28 sales since 1953, the industry has paid out more than $384 million — $72 million at Texas sales and $312 million at Louisiana sales — for the 1.5 million acres just mentioned. But for the 2.6 million acres bought before 1949, the cost was under $32 million — $7.2 million for 400,000 acres off Texas and $24.3 million for 2.2 million acres seaward of Louisiana. A dramatic contrast!

Two important facts are not reflected in the cost figures recited: The steady drop in per acre costs of Texas acreage since 1953; and the rapid rise in Louisiana prices during the same period. Furthermore, average prices are deceptive. The cost of prime acreage is buried in them. A structure of the first quality off Louisiana has recently brought as high as $2000 per acre. On the other hand, the best off Texas has only drawn bids of under $200 per acre. From a high of $2000 per acre, Texas prices have fallen to their present level. And acreage prices at Louisiana sales have risen progressively from $400 to $1000 and, of late, to $2000 per acre.

The Early Birds

Today, the best prospects come high, very high, particularly off Louisiana. For example, the $41 million one group had invested in 346,000 acres off Louisiana as of January 1, 1957 would probably buy them no more than two first class structures, 20,000 acres, now. The reward for taking the plunge early is obvious. It remains to be seen whether the present high prices can be justified on the basis of future developments. If the Texas experience is any

■ Buna N "O" Ring is fitted into top of valve seating core, in a groove with larger area than "O" ring itself. This allows approximately 30% contact with underside of bowl retainer ring machined smooth for "O" ring to "ride upon." Sand, other abrasives and moisture cannot enter valve's operating mechanism and lubricant is retained in mechanism for longer periods of time. "O" ring resiliency permits pressure to hold ring securely rather than force it from groove.

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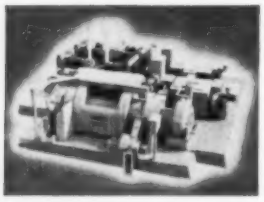
OFFSHORE-ONSHORE-INSHORE

Ideco Full-View mast on inshore barge in southern Louisiana.



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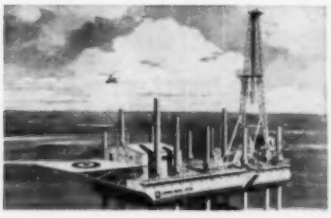
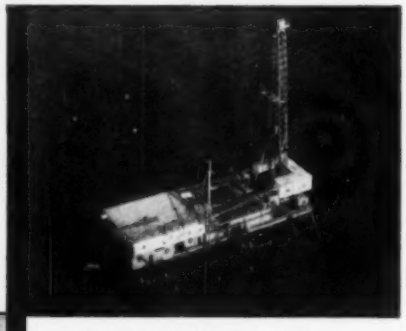
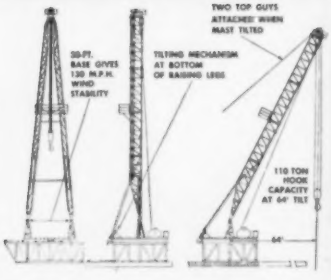


ELEVATING DECK, SPUD-TYPE BARGE—For drilling depths to 70 feet. Equipped with E-2500, 143-ft. Full-View mast.



FIXED DECK, SUBMERSIBLE HULL—143 ft. easy-to-lower Full-View mast adds hurricane protection, towing stability.

FIXED PLATFORM, SELF-PROPELLED TENDER—Ideco Electric 2500 featured . . . gives maximum capacity, uses minimum platform space.


TWO TOP GUYS ATTACHED WHEN MAST TILTED
30-FT. BASE GIVES 130 M.P.H. WIND STABILITY
TILTING MECHANISM AT BOTTOM OF RAISING LEGS
110 TON HOOK CAPACITY AT 64° TILT
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30-FT. BASE "TILTING" FULL-VIEW—Gives extra wind stability to 130 m. p. h. Doubles as crane to set production platforms.

WORLD'S TALLEST FLOATING STRUCTURE—Has tilting Full-View mast. See diagram at left. Drills multiple wells with movable substructure.

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criterion, a slip in the success ratio will result in a price break, a distinct possibility as the prime structures are drilled up.

Of the area platted off Louisiana, nearly 20 percent, over 1.8 million acres, was under lease at the turn of the year. The total represents about 57 percent of the acreage leased since 1945. The industry has invested in present Louisiana leaseholdings in excess of $325 million. Approximately 8 percent of the Texas submerged lands platted, 792,000 acres, was held by lease on January 1, 1957; roughly 75 percent of lands leased since inception. The leasehold investment by industry off Texas is around $72 million. Faced with an investment of such magnitude, the question which occurs is "has it been worth it?" Indeed, it has!

Success!

The most successful area has been Louisiana. At the beginning of the year, 108 prospects had been tested with 190 wildcats. This exploratory program established the existence of 74 oil and gas fields. A strike ratio of 40 percent, when compared with the national average of 11 percent, is phenomenal. To be sure, not all the discoveries are major, but some definitely fall in that category: Giant fields with expected ultimate recoveries in excess of 100 million bbl. Since less than 200 giant fields — ultimate reserves of 100 million bbl or better — are the backbone of the nation's production, providing about 50 percent of the country's reserve and last year 41 percent of its crude oil production, the results so far have been encouraging — which understates the case.

While Louisiana has lived up to expectations, Texas has not. With 30 prospects tested, only 8 oil and gas fields, none in the major category, have been uncovered by the 53 wildcats drilled. A strike ratio of 17 percent leaves something to be desired. But lightning may strike yet.

When referring to the offshore, the adjectives, fabulous and fantastic, have a way of creeping in. They are not out of place but are often overworked. A sobering set of statistics should be kept in mind when the pulse beats too fast. Almost as many wells have been drilled offshore (1428) as have been drilled in the Middle East (around 1500). But whereas most observers estimate the Middle East's proved crude oil reserve at over 125 billion bbl, the *possible* reserve of present offshore discoveries cannot exceed 2 billion bbl. And on a reserve-per-foot drilled basis, the Middle East outdoes the offshore 200 to 1. But, setting such comparisons aside, a proved reserve of 620 million

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36 bbl oil per day		55 bbl oil per day
558 bbl water per day		630 bbl water per day
74% pump efficiency		85.5% pump efficiency
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Interestingly, this tension tubing anchor was run strictly to prevent rod jobs. Yet look what happened to pumping efficiency!

The Double-E Tension Tubing Anchor

HERE'S WHAT IT DOES: Efficiency in a pumping well increases tremendously when the tubing is correctly anchored in tension! Here's how:

1. You get more fluid lifted per stroke
2. Working life of tubing and rods is increased
3. Rod jobs are greatly reduced
4. Collar leaks and wear are eliminated

HOW TO USE IT: Install the tension tubing anchor above or below the pump – or at any desired depth. Set the tool by rotating the tubing a partial turn to the left. Then exert an upward pull on tubing string. The tubing is now anchored in tension.

HERE'S HOW IT WORKS: With its powerful grip on casing, tubing is now held motionless. This eliminates wear between tubing and casing. Also, with strain of load-reversal off the tubing joints, costly collar leaks and damaged threads are prevented. You get much more fluid lifted per stroke and an increase in working life of entire tubing string.

HOW TO RETRIEVE: Simply lower and rotate the tubing a partial turn to right and anchor is re-jayed. If re-jaying is impossible, merely exert a straight-up pull *in excess* of the Slip Failure Rating*. The Double-E Tension Tubing Anchor is designed so the slip-flanges shear upon excess pull. This releases the slips and the tubing string can be easily retrieved without loss of parts in the hole.

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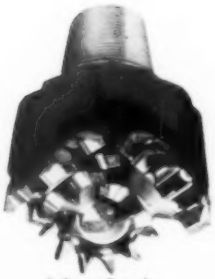
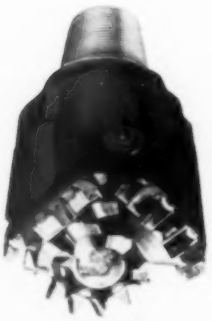
make better rock bits!



3-Cone Regular



3-Cone Jet

Modern methods make the modern Reed Y Bit

REED'S modern IBM Automatic Computer can reduce complicated data on rock bits in a matter of 90 seconds that would require an engineer many days to compute by ordinary calculating methods. Predetermined data on punched cards are fed into the intricate reading, memory, and selector units to be processed at the rate of approximately 138,000 logical decisions or "electronic thoughts" per minute.

Here are just a few of the problems encountered in rock bit manufacturing which may be resolved with far greater speed and accuracy by electronic data reduction. More efficient production and inventory control can be maintained to insure adequate sizes and types of bits when and where they are needed. In design and dimensional research, many engineering possibilities may be explored and evaluated before translating them into working prototypes. Equally important are certain problems in heat treatment which may be resolved by mathematical analysis in the IBM system far more rapidly than by destructive physical analysis of the metals.

This is REED progress—continuous improvement of product through modern methods—to provide more efficient, faster drilling rock bits.

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Latest development in controlling drill mud weights is the Dorr-Oliver ClayJector. This new unit is designed specifically for weighted muds . . . will mechanically reject undesirable drilled solids and retain the valuable barites (weighting materials) in the system. Optimum solids content is maintained at a minimum cost for barites which would be lost if solids are controlled by dilution and jetting tanks.

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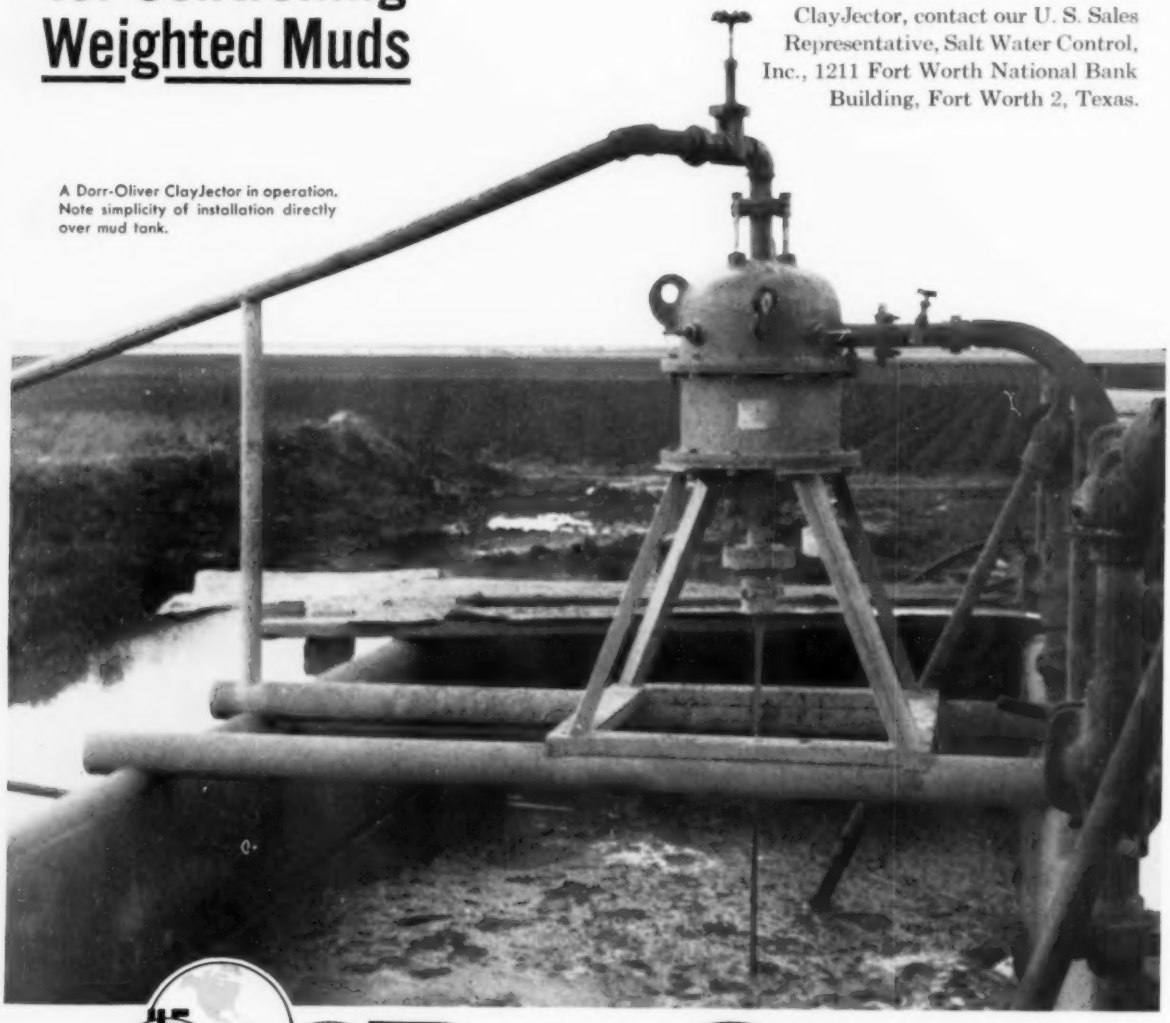
For more information on the ClayJector, contact our U. S. Sales Representative, Salt Water Control, Inc., 1211 Fort Worth National Bank Building, Fort Worth 2, Texas.

A Dorr-Oliver ClayJector in operation. Note simplicity of installation directly over mud tank.



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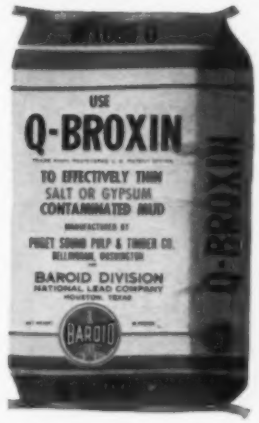

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Particularly effective in muds contaminated with salt or gypsum. Q-BROXIN makes it possible to effectively reduce gels in gyp mud, salt water or salty muds.

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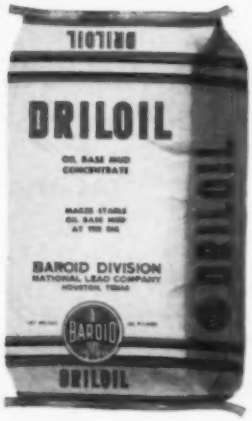

DRILOIL*
Makes oil base muds for drilling or for spotting opposite formations where completions are to be attempted. DRILOIL is easy to spot, easy to pump out. Get better cores; do wireline jobs easier with DRILOIL mud. WATER BAN* is the active ingredient in WATER BAN inverted (water-in-oil) emulsion muds. Filtrate is all oil in both muds.

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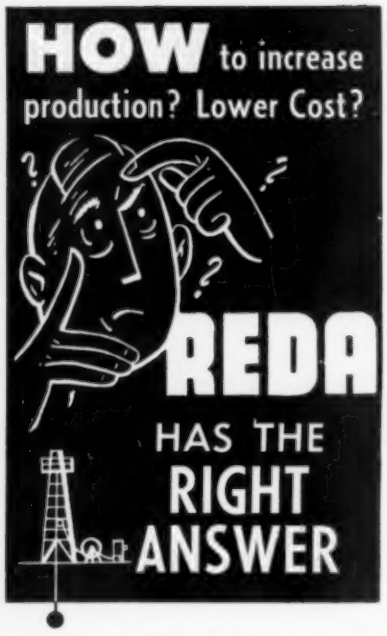

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'Experience and research should force cost reductions in many operations'

bbl of crude oil and condensate and more than 4 trillion cu ft of natural gas offshore is hardly insignificant.

Production statistics on the offshore area are rather misleading. The lack of pipelines has retarded oil production, and until further development drilling has been accomplished, this lacking will persist. The numerous gas fields are, with a few exceptions, all shut in. But production from the Gulf cannot be termed unimportant. At the first of this year, cumulative production of crude oil and condensate stood at approximately 110 million bbl and cumulative natural gas sales approached 250 billion cu ft. During December 1956, crude oil production averaged 155,000 bbl a day. Louisiana accounted for almost all of it. Natural gas sales during the same month were in excess of 360 million cu ft per day. All from Louisiana.

Alas — A Lack

There is a dearth of offshore pipelines and gathering systems, but they do exist. The Marine Gathering Company has two lines into Pure's Block 39 field, Vermilion area. United Gas Pipe Line Company has a line to the Block 32 and Block 45 fields in the Eugene Island area. And the MCN marine group have a rather extensive gathering system which services their Block 45, Block 126 and Block 128 fields, also in the Eugene Island area. You will note the one similarity between these three gathering systems is that they service proven and comparatively well-developed fields.

Plans exist for other lines. Some are being implemented. For instance, the two Tennessee Gas lines: One in the West Delta area; and the other in the West Cameron, East Cameron and Vermilion area. The West Delta line began receiving this month. The line to the Cameron and Vermilion gas reserves should be under construction this summer. Proposals such as Transcontinental's for the transportation of the West Cameron Block 110 gas are becoming more common. But the test of adequate reserves and deliverability, a test which most offshore fields cannot yet pass, remains paramount. How could it be otherwise when a line such as the MCN dual phase to Block 126 costs in excess of $7 million.

You now have what might be called a pencil sketch. The picture is there, but it is not detailed enough to portray the scene as it really is. The air of simplicity which it possesses is delusive. The complexities and problems which distinguish Gulf operations are not depicted. And they are legion, of all varieties, natural and man-made.

The first and most obvious difficulty confronting the oilman turned sea-dog is the Gulf of Mexico itself. From the seabed to the atmosphere above, the Gulf is full of surprises, the majority of them unpleasant. And none of them can be avoided.

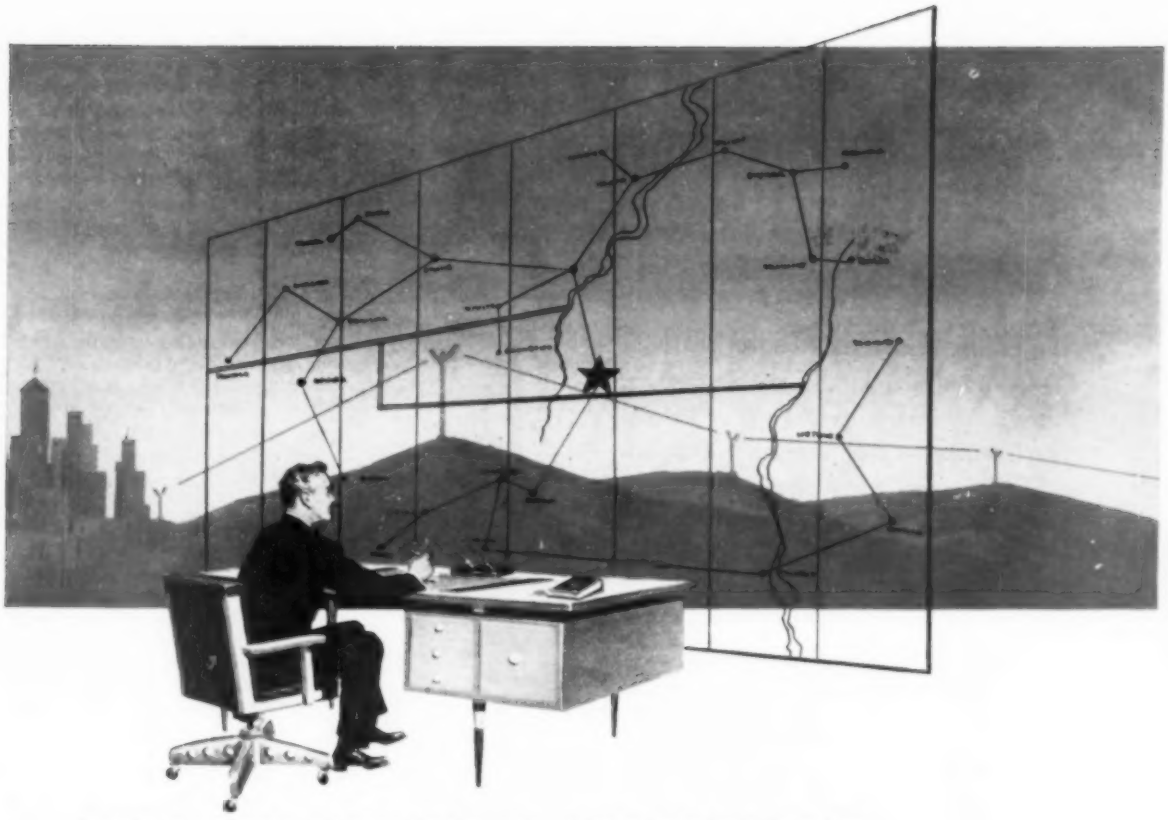
Why should a seabed occasion difficulties? The bed itself is answer enough. The silt deposits, particularly off the coast of Louisiana, can and, at times, do run hundreds of feet deep. To be sure, there are areas where the soft and yielding silt presents only a slight problem. But since mobile units require firm resting places and platforms must be supported by pilings secure in place, the seabed is an obstacle.

Dangers

The calamity that recently overcame Glasscock's "Mr. Gus," a 3.5 million dollar investment, is certainly adequate proof that a shifting seabed can spell disaster. An engineering miracle designed to withstand winds up to 125 mph toppled largely due to a loss of footing. Kermac's Rig 40 almost went the same route within the past few weeks. The Golden Meadow disaster, which cost nine lives, began because of a seabed shift. The dangers inherent in the ocean floor cannot be minimized. To overcome them and eliminate some of the hazards, soil borings and other testing devices have become important tools in the preparation of drill sites.

The sea has fascinated generations of men. Many of its secrets are known, but the power of its chemistry has yet to be measured. Will steel pilings and underwater pipelines be able to withstand the ravages of salt water and its jealous guardians, animate and inanimate? All known precautions are being employed in an effort to forestall the attacks of the sea, but time only will render the decision.

Overshadowing all other factors in the seaward search for petroleum reserves is the hurricane. The drawing board and simulating conditions produce wonderful results, but there is no test like the real thing. When "Flossie" hit last summer, offshore operators were delighted to find that the damage she inflicted was relatively minor. They had built well. But the big blow has yet to hit. May we again have our faith justified!



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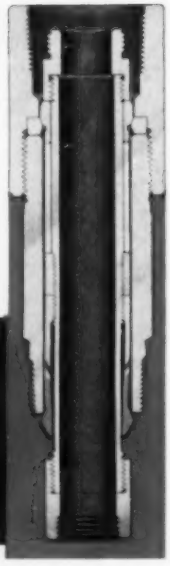
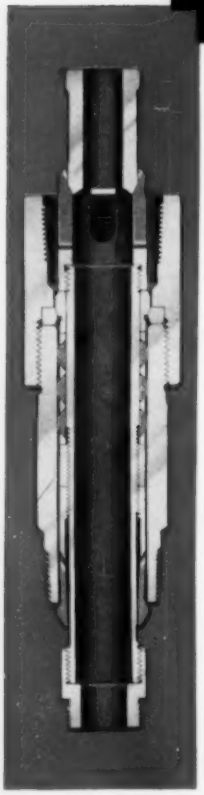


Undersize rings can also be furnished to allow pumps to be run through a Permanent Completion "S" Nipple and seated in the pump shoe.



If at any time the Stainless Sealing Ring Seat, which is part of the Tubing Assembly, should become damaged or leak, an effective seal can be obtained without pulling tubing. The Rod Assembly is engineered and designed so that by replacing the Spacer Ring on the Hold-Down Lock Body with three Ring Type Seating Cups, the seal is transferred to the Seat Support Nipple with the Sealing Ring and Sealing Ring Seat serving as a No-Go ring and supporting the load.

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Oilman's New Neighbors

The oilman is a rank newcomer at sea. And those men who preceded him in the exploration of the ocean's "crops" are not exactly overjoyed at his presence. The fisherman and the oysterman are particularly zealous in the guardianship of their own provinces, as well they should be. Any action which disturbs their operations or, in any way, affects their "crop" is met with strong counteraction. Happily, while there have been some misunderstandings, the relationship between the three parties is, on the whole, good. But in order to maintain good feelings, careful planning is necessary.

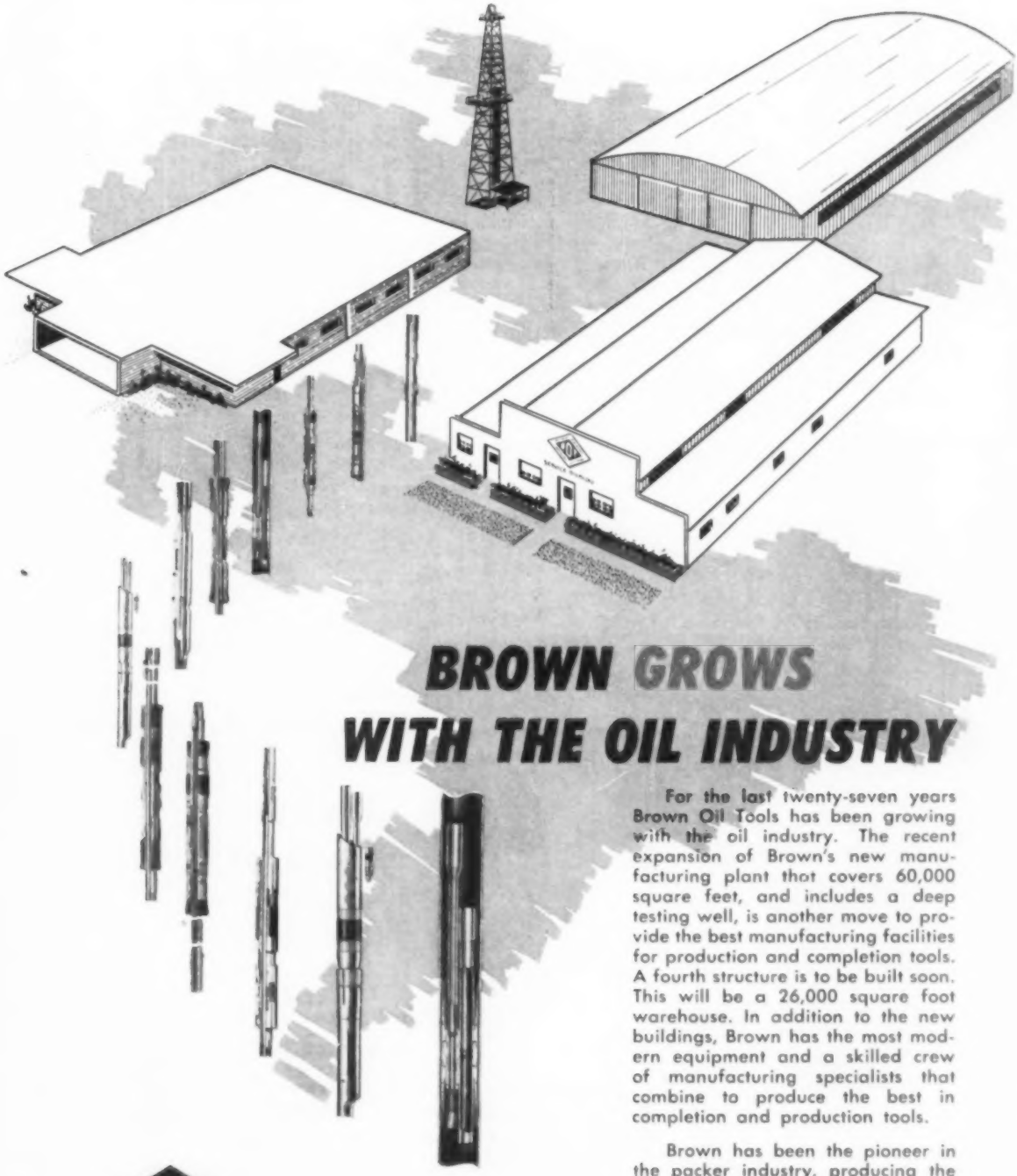
When geophysical operations went on a large scale basis, the industry was accused of decimating vast quantities of fish. These accusations were unfounded but nevertheless persistent. Fortunately, complete cooperation between the industry and the several governmental agencies concerned with the conservation of wild life has quieted the rumblings and dispelled any anxiety over the safety of the fish world. And any seismograph program down to the size of the charges to be used is planned in strict conformity with the regulations governing such operations.

Eating Your Profits

If you have operations east of the Mississippi Delta, oysters are a real problem. While they are a delightful dish at Arnaud's or Brennan's, they can taste terribly bitter if you have just bought a whole bed of them because you forgot to check the oyster leases on file at the Wild Life and Fisheries Commission. Some operators have done just that. And numerous claims of damage to beds due to drilling or seismograph operations have been made and paid. Extreme care is, therefore, necessary before any operation is begun in the area.

The Gulf of Mexico doesn't resemble a pin cushion yet, but enough structures are in place to create problems in regard to shipping. The petroleum industry and shipping interests, together with the United States Coast Guard and the Corps of Engineers have formulated plans designed to prevent unnecessary mishaps at sea. Elaborate warning and lighting devices are being installed, under the guidance of the Coast Guard, on all units in place. Every conceivable precaution is being taken to contain the possibility of accidents.

If shipping could be confined within carefully defined corridors, a serious problem would be solved. An attempt has been made, an unsuccessful one. The Corps of Engineers, with the aid of mariners and oilmen, has laid out a system of fairways and anchorage



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areas. Drilling is prohibited within the fairways and restricted within the anchorage areas. And if ships could be compelled to use them, the problem would cease to exist, but they can't.

The United States has absolutely no control over shipping beyond three miles from its coastline. The Federal Government can lease the seabed and permit the erection of drilling structures beyond its territorial waters, but its power over the movement of ocean-going vessels is nil.

Thus, like many neat little solutions, this one is ineffectual, though not completely so. The corridors are there, even if they aren't used. But the location of these restricted areas is causing concern and changes are causing expressions of alarm. A battle over fairways and anchorage areas is unquestionably in the offing. Arbitrary shifting of a strip two miles wide is bound to carve out a sizeable portion of someone's pet prospect or impinge upon someone's producing operations. Therefore, any proposal relating either to fairways or anchorage areas will surely receive careful scrutiny by the petroleum industry. Actually, they are the only ones seriously affected.

No Man's Land

Everyone has a finger in the pie so to speak. Fishermen, oilmen, federal agencies and state agencies. Not to be outdone, so does the Navy and the Air Force. Vast areas have been set aside in the Gulf to be used as gunnery and bombing ranges. Naturally, nothing as permanent as a drilling structure could be erected within the limits of any range. If the status quo could be maintained, these ranges would be of no concern. And if the report to the House by its Interior Committee recommending legislation which would require congressional approval of all military land withdrawals in excess of 5000 acres is translated into law, such would be the case. The status quo would be maintained. But unless the recommended bill or one like it is passed, the threat of new reservations, reservations of the magnitude of the Navy's revised W-92 area off Louisiana, one of the areas which triggered the present congressional action, will remain a factor of real importance in assessing future offshore operations.

In an era of inflation, costs occupy a dominant, indeed, a controlling position. And no phase of offshore operations has received broader publicity and attention than the price of doing business. The figures are a bit staggering. Mobile units such as the new "Mr. Gus" which has a tag on it of $8.5 million, self-contained platforms which, together with their above deck equip-

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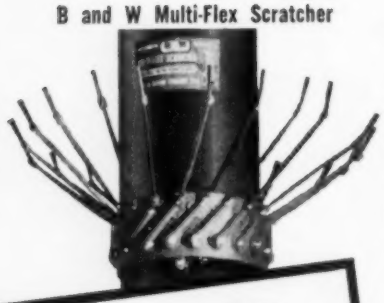

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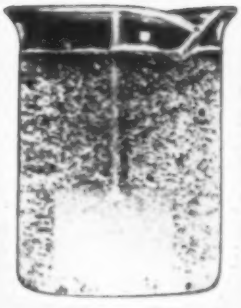

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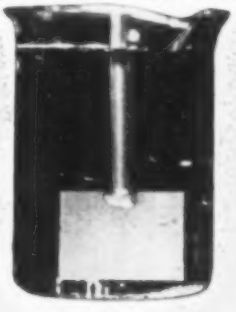

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ment, require an investment of $1.3 million, and drilling costs on 14,000-ft exploratory wells which exceed $650,000 — all are rather unnerving to the uninitiated. But these enormous sums are misleading. On the basis of reserves given the offshore and API reserve figures for the Nation covering the period from 1947 to 1955, it has been noted that each offshore well — exploratory or development, dry or productive — has added to reserves about nine times as many hydrocarbons as the average onshore well during the same period. Thus, although an offshore well will cost about nine times as much as its dry land counterpart, the costs of drilling and equipping such a well are not as far out of line as it might appear on first glance. But the cost and investment picture is cause for concern.

As of January 1, 1957, it is estimated that the industry had invested over $1.7 billion in the offshore search for petroleum reserves. There is no doubt that this estimate is low. Overhead and operating costs, the investment which the many service companies have made and other major expenditures are not included in it. A more realistic figure would be $2.5 billion.

With the estimated gross income total just barely exceeding $250 million, such an investment figure is disturbing. The rush to accelerate the production of income is, therefore, not surprising. The interest on an amount of that magnitude is enough in itself to cause a quickening of pace.

Haste Makes Waste

The conflict between a stepped-up development program and the reduction of dry hole costs is obvious. Abandonment of a deliberate development program in favor of a more rapid one will, most likely, result in an increased number of dry holes. And while the offshore compares favorably with the onshore in this regard, the percentage differential is not good enough. But with the equally obvious advantages to be gained from a quicker payout, it is in the area of reducing the number of dry holes that the hardest thinking must be done. The assurances that the reduction can be accomplished are heartening.

The cost picture has many facets, and all cannot be covered. But one which has been met with a certain degree of success should be mentioned. Platform costs, as we have seen, are considerable and cannot be avoided. Before the rotary table makes its first turn, the platform is bought and paid for. But despite a 6 percent increase in steel and labor costs over the past few years, the cost of fabricating and installing platforms has held. Improved technology and experience enabled operators to hold back any upward movement in cash outlay. In the days to come, added experience and continued research, resulting in further technique improvements, should make it possible not only to hold the line but also to force a cost reduction in many phases of the operation whether it be platform costs or transportation costs. The pressures being relentless, the desired end — lower costs — would seem inevitable.

A Just Return

The existence of an enormous investment and the recognized necessity of continued expenditures on a tremendous scale demand an adequate return on the dollars poured into the operation now or in the future. And as any deferment of income on investment will be extremely costly, the sooner returns are forthcoming the better. The emphasis on development is explicit recognition of the losses which would be incurred, if production, and, therefore, income is not raised appreciably. But even if the capacity to produce is increased, it will be of no avail unless allowables permit the extraction of hydrocarbons in sufficient quantities to ensure a return on the investment. This

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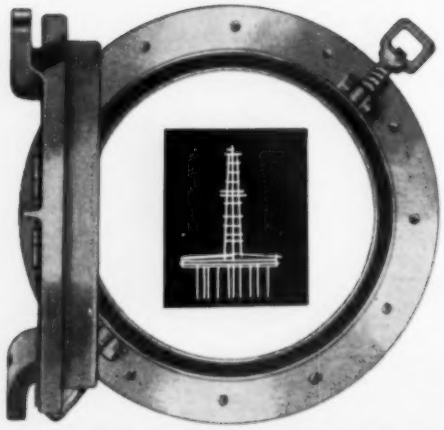

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is a chronic problem in other areas. However, offshore it has assumed a position of enormous importance.

Per well allowables have been dropping steadily, with some intervening but shortlived upward movements, for the past several years. In accordance with their established practice, Louisiana has maintained an allowable differential between onshore and offshore wells which has continued despite the fall in the per well production allowed. The State of Texas does not have a system comparable to Louisiana's. And increased allowables for Gulf wells are not obtainable west of the Sabine, although the discovery allowable method dulls the pain somewhat.

In the view of most observers, the present allowables, Louisiana's or Texas', are not enough to provide either a proper and timely return on monies invested or the necessary stimulus, on a continuing basis, for further development and exploration of the Gulf area. The seriousness of this situation is obvious.

It's the Law

When the Tidelands Acts were passed, some wag quipped, "these acts should be called laws for the relief of lawyers." And as many a truism is uttered in jest, it has not been surprising to the people involved in offshore operations to find the remark awfully close to a statement of fact.

Representative Willis of Louisiana will head a House Judiciary Sub-committee which is presently embarking on a survey of the situation, and he will find a "legal jungle." The question of which law, state or federal, to apply to operations offshore is the basic one.

The status of drilling platforms (Are they artificial islands or are they in the category of vessels?) will determine whether the application of maritime law will constitute a further complication.

When a worker on an offshore drilling operation was recently held by a court to be a seaman, the decision had widespread reverberations. Is a strike on a drilling platform a mutiny at sea? The unanswered questions are endless.

Willis and his cohorts may attempt to bring some order out of this sea of legal conflicts, but it is a good bet that the courts for years to come will write most of the answers.

Whose Water?

The dispute, a legal one, which enjoys the greatest notoriety is the one involving the question of ownership, state or federal. When the United States attorney general filed suit against Pacific Western Oil Company in May of 1945 claiming, for the United States, fee simple title in a certain lease under the tidewaters abutting the State of California, the first shot was fired in a battle which has raged for years. The States of Louisiana and Texas became involved in suits with similar objectives on the part of the United States Department of Justice in December 1948. Not until 1953 was the air cleared but then only partially. The language of the Submerged Lands Act provides that the territorial limits of states fronting on the Gulf are to their historic boundaries but in no case shall such limits exceed three marine leagues or 10.5 geographical miles from the coastline. And on this point, which was most certainly a recognition of the strength in the claim of Texas, the battle has again been joined and continues to rage.

Since 1955, the boundary of the State of Louisiana has been a matter of litigation. The United States is pressing for a decision limiting the State's jurisdiction to three miles.

Using the argument that a boundary of three miles has been the traditional position of this country in international affairs over the years, the Justice Department, in the minds of most observers, is setting the stage for an

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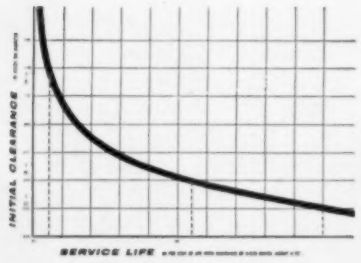

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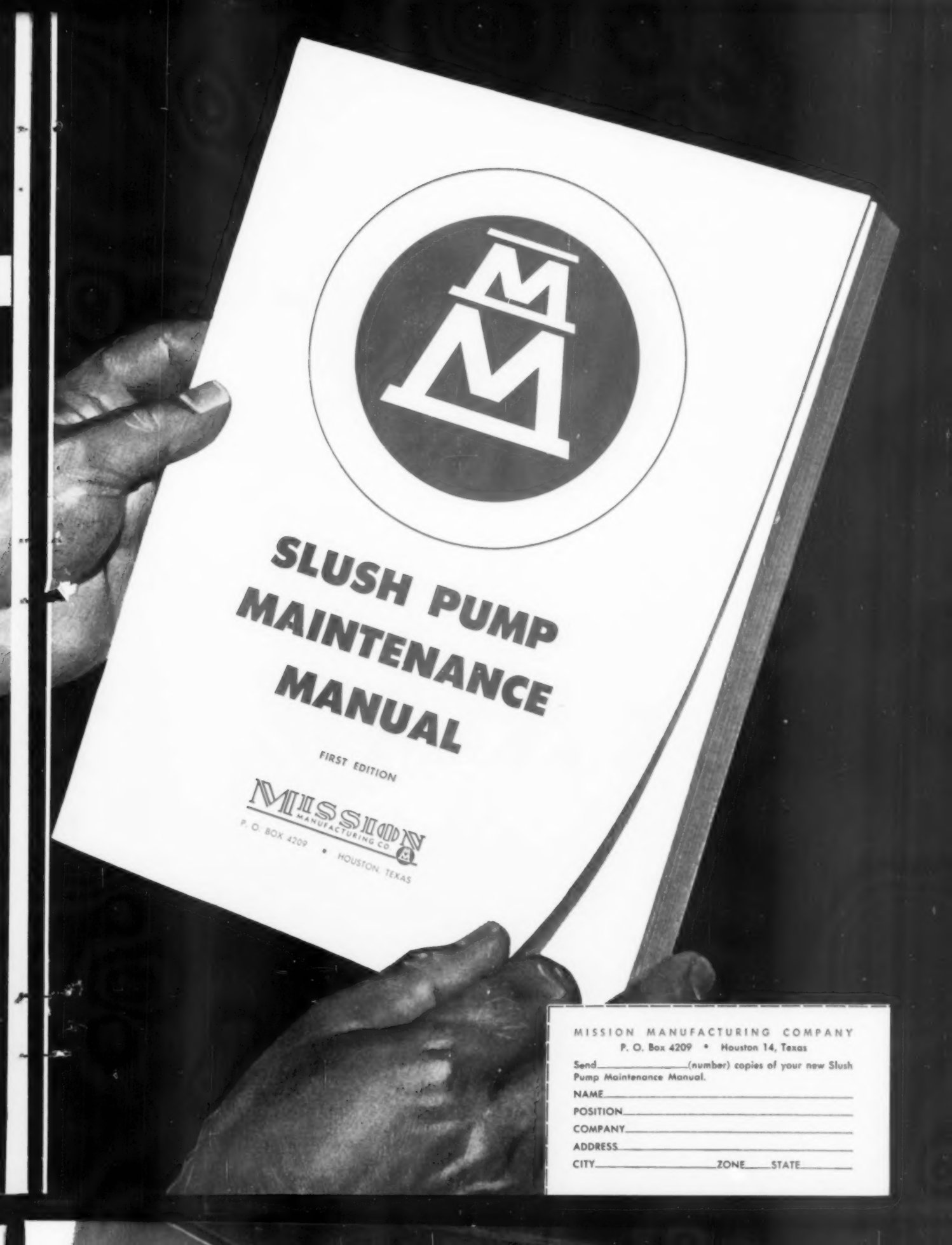

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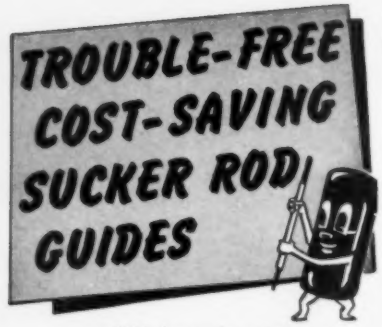

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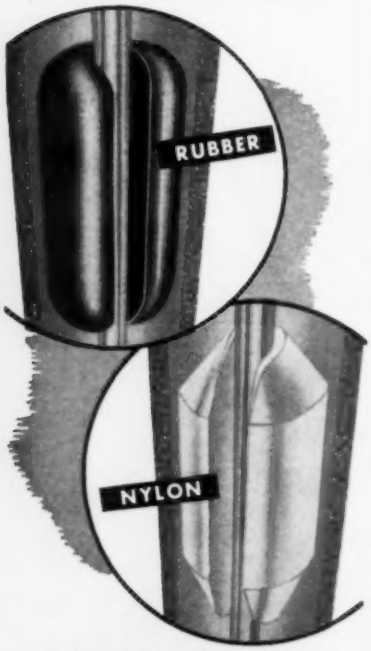

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What would happen if lands beyond three miles were ruled beyond U. S. limit?

attack upon the claims of Texas and Florida.

The fact that the matter of coastline delineation, a difficult and vital question in the case of Louisiana, is not a part of the Federal Government's case against that state lends great strength to such a theory. How the case will come out, no one can tell. But for operators in Louisiana Gulf waters, their difficulties will be only half over unless the Supreme Court takes it upon itself to effect a solution of the coastline question, too. An adequate discussion of this title question and its many ramifications is not possible here, though it really deserves thorough treatment. However, in passing, mention should be made of the fact that it has compounded operating difficulties for the industry. Double rentals and double royalties have been paid to protect disputed leases. Shut downs have blunted and slowed an effort which took years to get into high gear. The costs arising from the uncertain lease situation have been tremendous. How great a financial burden a shut down can be was illustrated, most emphatically, by the shut down resulting from the Supreme Court injunction of June 11, 1956. Although the effects of the injunction period on the industry were substantial, they were not devastating. The economy of South Louisiana was hit hard. Fortunately, the injunction, in all its aspects, was not long lived. Since October 12, 1956, Louisiana operations have been conducted under the terms of a state-federal agreement which fortunately eliminates many of the risk factors. But the basic questions remain unanswered. Unfortunately, it could take years for the answers to arrive.

International Intrigue

The Continental Shelf and its ownership is a legal question which, in international law, has no answer. All nations with their own national interests to consider view the matter according to their own lights. And there are a variety of positions taken on this point within the community of nations. The basic conflict is between the "Freedom of the Seas" concept and "the right to extract mineral resources from the seabed of the Continental Shelf" theory, fishing rights occupying a middle position.

The thinking of the United States which claims territorial jurisdiction only to three miles but rights as to the seabed beyond its territorial limits and to the edge of the Continental Shelf is a unique one. Many claim it has no basis.

But through the International Law Commission, a creation of the United Nations General Assembly in November 1947, an attempt is being made to establish on an international basis the American concept. What happens if a concept contrary to it is finally adopted? While the question may remain forever moot, the uncertainties of life in this world today could elevate it to one of paramount importance. And the consequences of such a happening would be nothing short of awe-inspiring.

The mere recitation of the problems inherent in the operation being conducted offshore is not the purpose of this talk. But the story of what is being done out there is not complete unless they are at least pointed out. Again, the apparent simplicity of this highly complex operation can be deceiving. To contemplate the many problems inherent in it is to disabuse oneself of a false impression!

Climax

When forecasts are made that "barring economic and political calamities, one should be prepared for a domestic demand in 1965 for petroleum liquids and natural gas 50 percent greater than the present demand," an area with the demonstrated potential of the Gulf of Mexico assumes a stature of great consequence. And when it is further estimated that "if such a demand materializes, and if the present ratio of net imports to domestic production is maintained, oil men will have to find far more petroleum in this decade than in any previous decade," the conclusion is inescapable that, in order to supply the demand, giant fields in quantity must be discovered. Equally inescapable is the conclusion that the Gulf of Mexico with its giant fields is today the most promising area available to the industry in its efforts to realize the goal of adequate supplies of petroleum for a growing demand.

With over 50 companies or groups of companies involved offshore, and with over 100 rigs in operation, the Gulf of Mexico will be compelled to live up to its promises or fall by the wayside. And in a business noted for its adventurous nature, a large segment of the industry is embarked on one of its most challenging adventures. ★ ★ ★

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Turn the page for a case history of diamond equipment in Offshore use.→

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Performance Report

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BIT DATA:

Description–12 waterway, spiral Design, "B" Crown
Size–7¾" x 4"
Diamonds–Large, first quality stones
Original Bit Sale Price–$4860.00
Net Bit Cost–After Salvage, $1500.12
Bit Cost per Foot–$3.24

Location:
Offshore from Morgan City, Louisiana

Formation:
Unconsolidated green shale and sands of Upper Miocene Age.

Performance:
This Christensen Diamond Coring Bit cored a total of 463 feet at 4 feet per hour and the operator recovered 448 feet of core. Other types of coring equipment were coring at 2 feet per hour, bit life averaged 12 feet, core recovery was approximately 40% and round trips were taking 7 hours each. The peculiar sticky, crumbling sand and shale, although only medium hard, presented a difficult coring problem. The formation would clog the bit, yet excessive fluid volume would wash the core. The spiral waterway design coring bit, with each waterway angled so fluid would flow across bit face, assured uniform cleaning and cooling of the diamonds. The Christensen Engineer also recommended a shim adapted to the core barrel to bring the inner tube shoe closer to the mouth of the bit, reducing to a minimum the area of core exposed to drilling fluid.

Operating Conditions:
Bit load — 6000-10,000 lbs. Rotary table speed — 40-50 RPM
Fluid volume — 170 GPM. Water depth — 60 ft. Remarks — Directional hole with 3 whipstocks set, no unusual drag encountered.

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Jetting down 36-in. OD caisson. Traveling block and hook support 1¼-in. thick wall caisson by means of bails while three flexible hydraulic hoses connect to feed lines welded to outside of caisson to supply jet ring on bottom with adequate volume and pressure.

Design and application of . . .

JET RINGS To Facilitate Caisson Penetration

Large diameter columns used to support offshore wellhead equipment can be installed more effectively by hydraulic methods

J. W. Peret, *Sun Oil Company, Dallas, Texas*

OVER the past several years, the drilling industry has seen a rapid increase in the use of mobile rigs in offshore drilling. With nearly 30 of these rigs now in existence and some six or seven currently under construction, their continued application is evident.

A necessary adjunct to the mobile rig is the caisson column, which is used to support the blowout preventer assembly and to suspend the weight of all casing landed in the well head, both attendant to the drilling operation. An added function of the column, in event a producer is made, is to support a small platform, used for personal needs and to accommodate the aids to navigation consisting of a horn and light as required by regulatory authority.

It is mandatory that the column avoid failure in its suspension of substantial subsurface casing loads. The environmental conditions in which these columns serve and the load bearing requirements imposed upon them are quite impressive. Loads of both a horizontal and axial nature are imposed and simultaneously so, as represented by vast wave forces and casing weight. The isolated nature of the column's location at sea makes it impossible to secure its upper end by fixed support; thus adding materially to the adversity of its environmental conditions.

In a given set of conditions when water depth is known and casing weight to be landed has been previously decided, design calculations permit the determination of appropriate caisson diameter and wall thickness. Such a columnar stiffness would be expected to provide successful resistance to buckling from axial loads and deflection from horizontal wave forces.

With insufficient penetration into the ocean floor, however, failure could be encountered by a column which otherwise was completely satisfactory. This is readily apparent when it is realized that the overturning moment is given by the wave force and affected columnar area; and that this must necessarily be completely nullified by the down-hole moment of resistance furnished by the soil opposing lateral movement of the buried column. With insufficient penetration, the lower end of the stiff column imposes a relatively strong side stress against the weak soil, causing it to yield or shift. Where this occurs, the vertical alignment of the column is destroyed, leading to a strong self-aggravated furtherance of deflection and failure. With greater penetration, the imposed side stress can be lowered to lesser and more bearable values, the acting lever arm is lengthened and an increasing resisting moment is obtainable with which to successfully resist wave forces. Thus the need for adequate and positive column penetration is paramount.

Caisson Placement

As a means of driving caissons, some rigs are equipped with a large hydraulic driving mechanism capable of delivering a downward driving force in the nature of 700,000 lb or more. In event caisson limitations, in the form of buckling or collapse contingencies, preclude the use of all this available force, experience has demonstrated the advisability of employing a jet ring on the lower end of the caisson in order to assist in preventing the occurrence of a premature driving reaction and to more positively assure the achievement of desired penetration depths.

Use of a Jet Ring

The jet ring is welded to the lower end of the caisson. Several vertical feed pipes supply fluid to the jet ring under high pump pressure; this fluid erodes and clears the rock force, transporting displaced material to the surface; and with adequate ascension velocities, skin friction between the caisson wall and hole are overcome. Thus, in the desirable absence of skin friction, all driving force can then be utilized for advancing caisson penetration.

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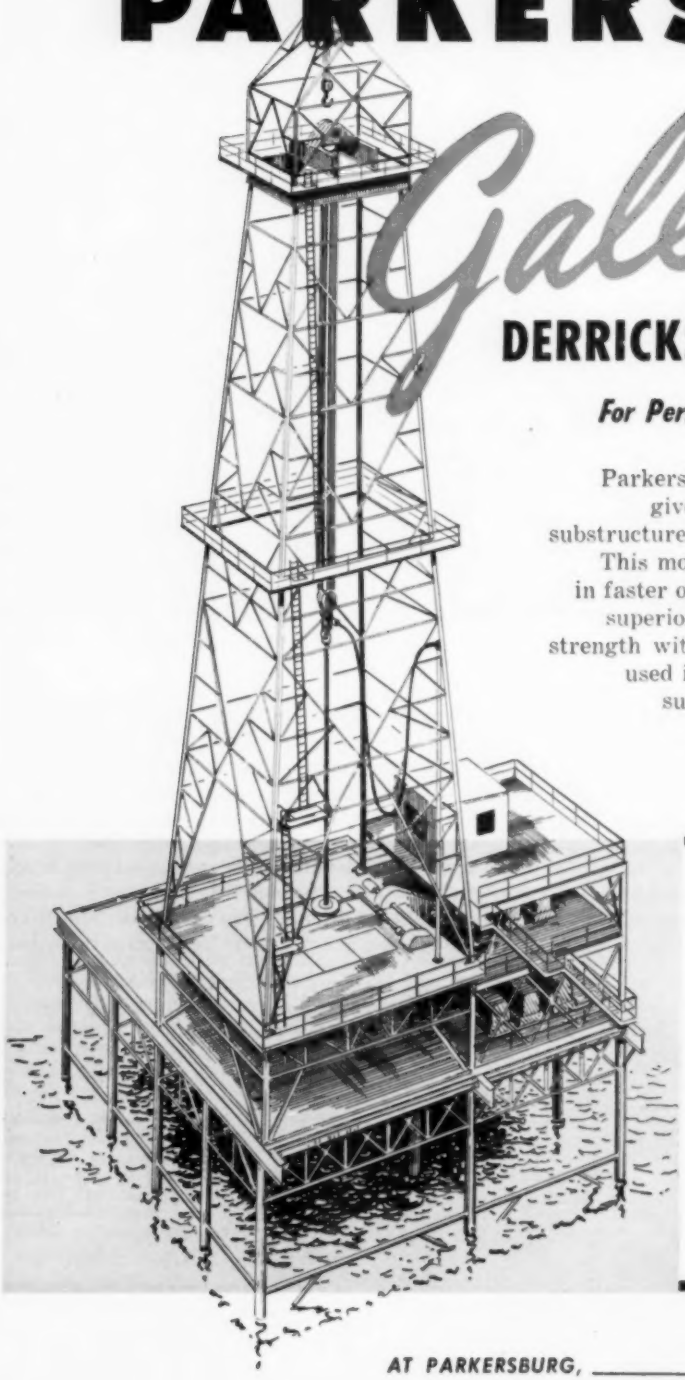

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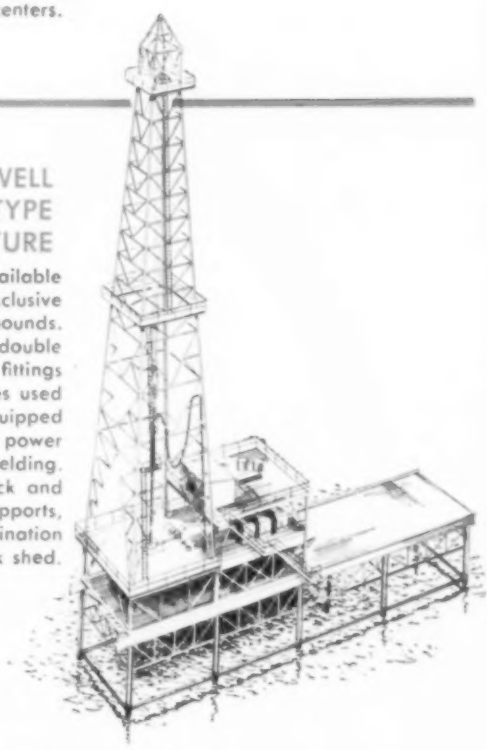
Derrick available in heights of 140′ and 147′ with base 30′ x 30′. Work load capacity 1,100,000 pounds. Gin pole lift capacity, 20,000 pounds. Crown block is lifted with gin pole hoist to move from one location to another.

2-Well Substructure is eight-post type 16′1″ high on 40′ skid centers.



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——DERRICK AND SUBSTRUCTURE

available in heights of 140′ and 147′ with base 40′ x 45′.

6-Well Substructure available in either six-post or 12-post types with floor heights of 23′ and 16′1″. Corner column capacity is 1,400,000 pounds. Trolley beams furnished for handling equipment used beneath the substructure.

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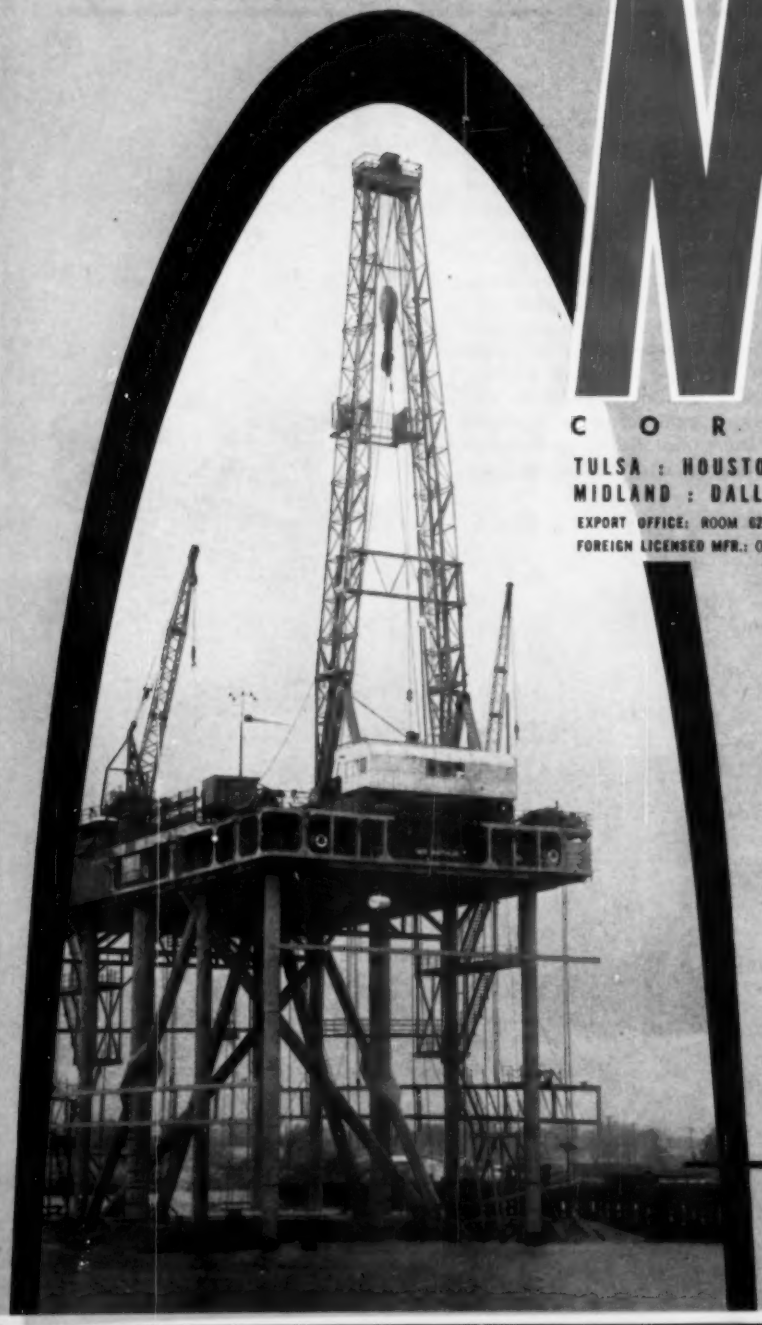
This mast has a gross nominal capacity of 1,000,000 lbs. with a 30 ft. leg spread at the base and can be lowered to a horizontal position for more stable towing of the barge or for added protection during hurricane conditions.



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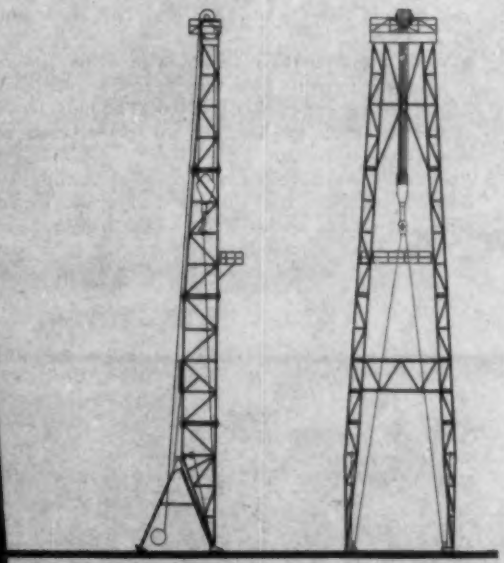


driller's side *front side of mast with 10' top*

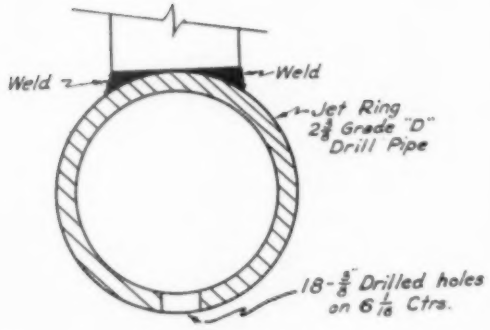


FIG. 1. **Cross section of jet ring** showing details of fabrication.

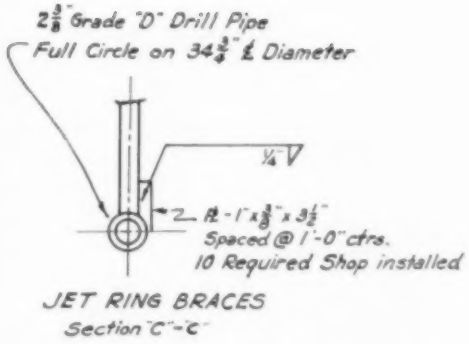

2⅜" Grade "D" Drill Pipe
Full Circle on 34⅜" ℄ Diameter
¼"
2 ℓ - 1" x ⅜" x 3½"
Spaced @ 1'-0" ctrs.
10 Required Shop installed
JET RING BRACES
Section "C"-"C"

FIG. 2. **Welded braces** help support jet ring in place.

pects of the jet ring will be considered. Fig. 1 shows 2⅜-in. OD Grade D drill pipe, selected in preference to tubing because of its superiority in wall thickness, resistance to collapse and overall strength. The ring is situated under the caisson in a centered position to receive direct vertical bearing with reduction of stresses tending to destroy weld bond. The fluid outlet directs the fluid stream downward in a vertical direction rather than at an inward or outward angle. This gives a neutral directional tendency to reduce the tendency of directional variance.

Fig. 2 shows the manner in which the external braces reinforce the weld attachment strength to prevent dislocation of the ring.

Fig. 3 shows a plan view of the jet ring and the equal circumferential spacing of the three weld ells effecting the juncture of three vertical supply pipes which feed pump-driven fluid to the jet ring.

Fig. 4 shows the method of construction in joining the heavy weld ells to the ring. During downward descent through compacted soil, the extended configuration of the weld ells subjects them to a degree of cantilever loading. To lend required resistant strength, a brace is inserted between the ell and caisson external wall. Further, to minimize earth resistance and cantilever loading, a fluid outlet is drilled in the ell to take advantage of fluid energy and its hole making or clearance effects.

Fig. 5 shows a plan view of the ring installed on the caisson. As can be noted, the ring width exceeds wall thickness. This leaves substantial hole clearance for the caisson wall, both internally and externally, reducing the effect of skin friction.

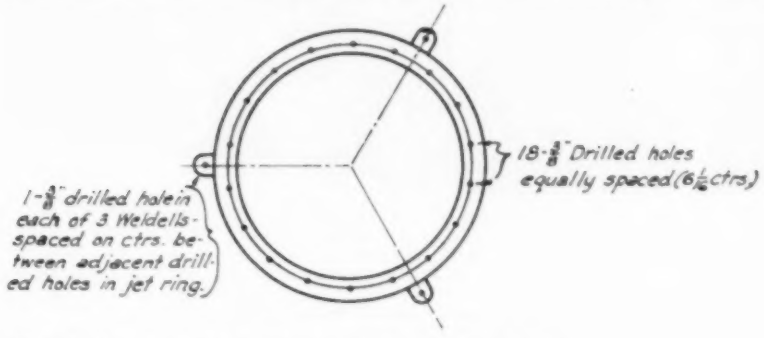


FIG. 3. **Bottom view** of jet ring showing spacing of jet holes in ring.

Installing the Caisson

Fig. 6 shows a sketch of operations with the caisson at terminal penetration. A brief resumé of running procedure starts with the field welding of the 40-ft caisson joints, which are suspended by the driving ring until sufficient length permits contact with the ocean floor. As the caisson is run, the feed pipes are attached externally by means of strong brackets which encircle but do not rigidly fix these pipes.

For good column performance, precise vertical alignment is mandatory and merits necessary precautions. Two plumb lines, situated on cross axes

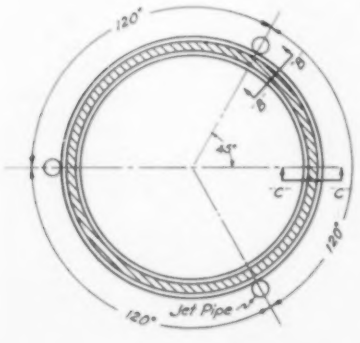


FIG. 5. **Manifold layout** showing location of vertical jet pipes.

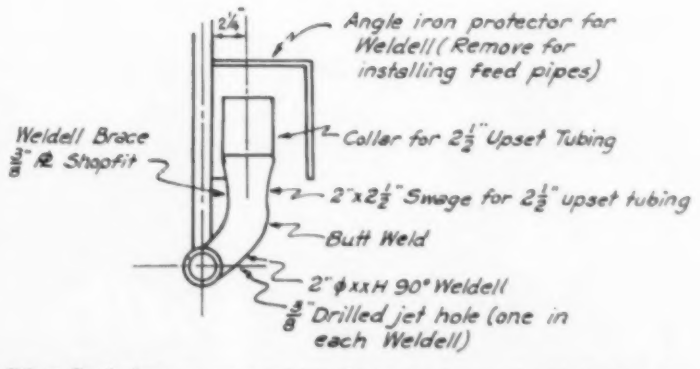
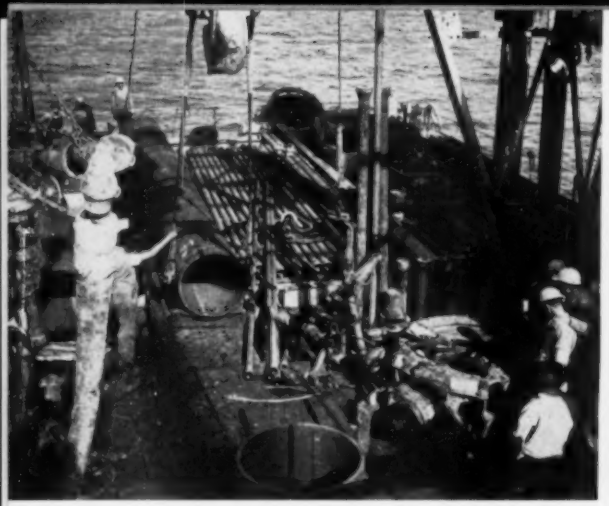


FIG. 4. **Feed pipes** are connected into the jet ring by use of weld ells taken thru Section B-B of Fig. 5.



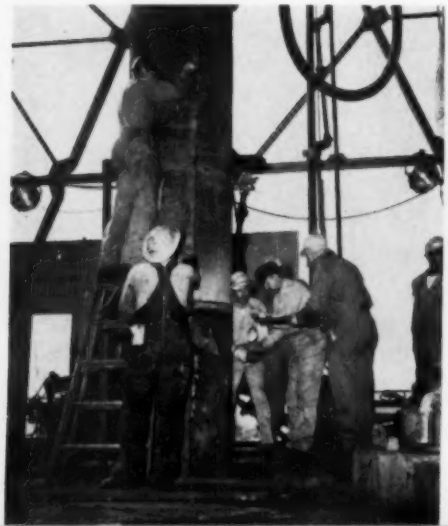
1. **Another 40-ft joint** is pulled from catwalk up into derrick for adding onto 36-in. OD caisson. Each joint was equipped with eyes for lifting.

2. **Centering new joint** into guides welded on end of joint sticking out of derrick floor.

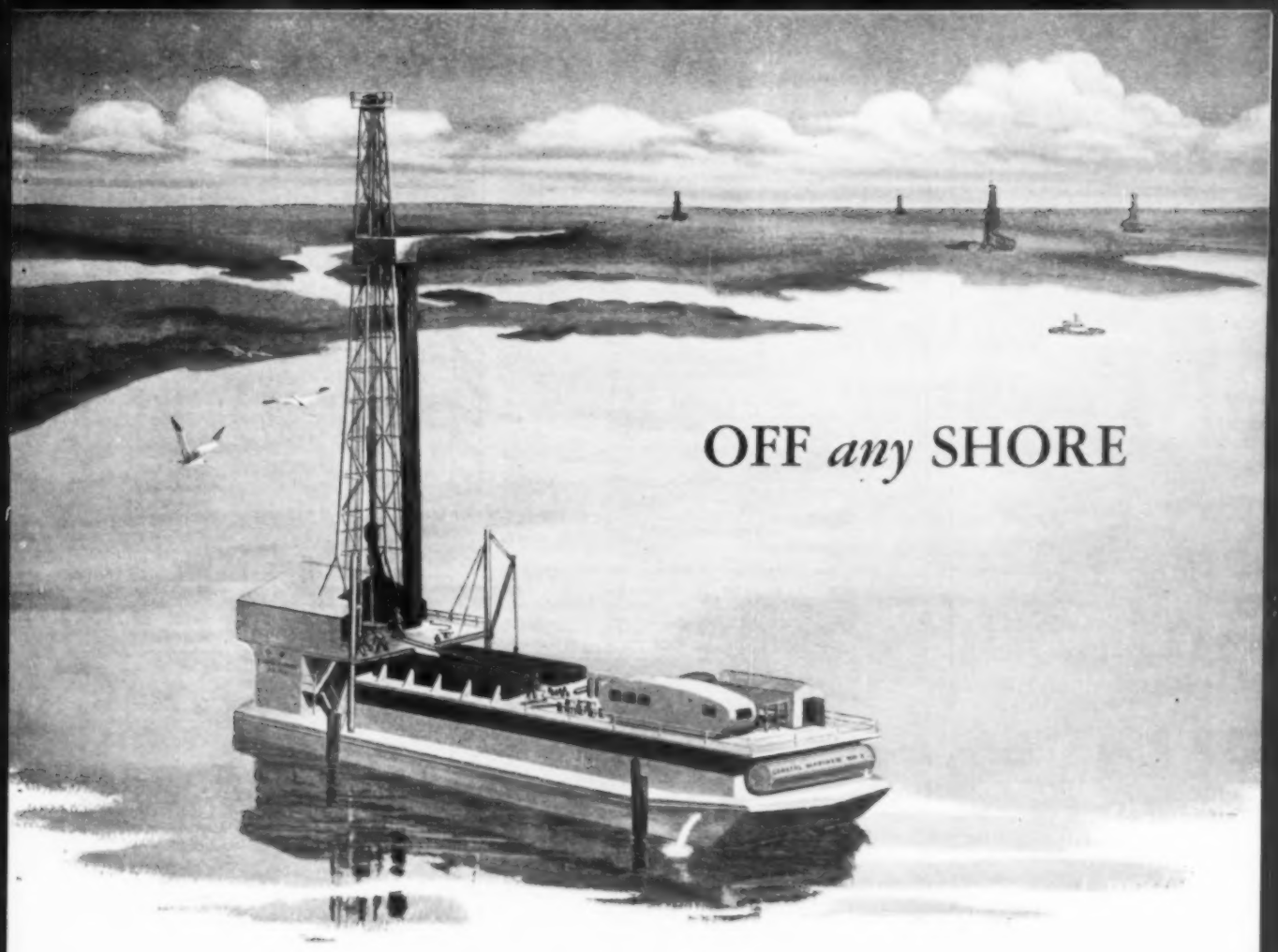
3. **Lining up new joint** by use of long spirit level prior to welding. Prefabrication of each joint facilitated (stabbing and centering).

4. **Welding new joint** to caisson column by team of welders. Each of 5 welds required an average of 1.87 hours.

5. **Author Peret** (with dark cap) sets up plumb bob system to check vertical descent of caisson while jetting and driving into place.



6. **Readying new joint** on catwalk while previous joint goes down. Each joint is 40 ft long, 36 in. OD with a wall thickness of 1¼ in.



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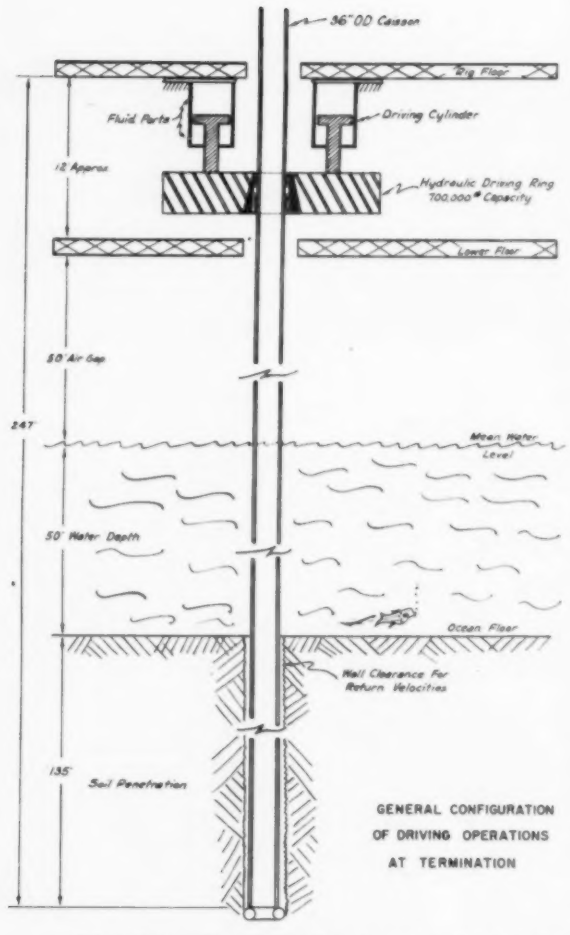
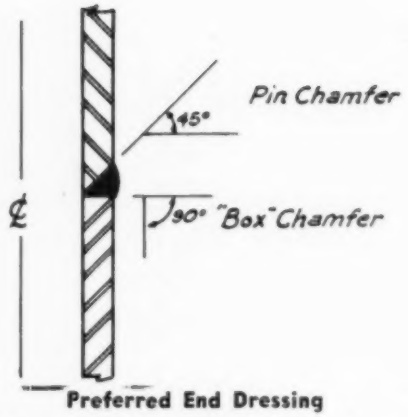
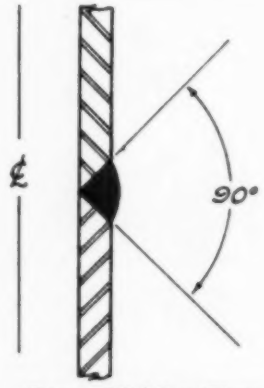


FIG. 6. **Schematic cross section** of caisson jetting operation showing use of hydraulic driving unit.



Preferred End Dressing

FIG. 7. **Dressing ends** of caisson sections and welding as shown saves considerable rig time.



Excess Welding Time Causing Excess Rig Time Cost

FIG. 8. **Bevelling both ends** and filling 90 deg trough requires excess rig time.

around the caisson, with each line having 15-ft spaced discs of bob diameter, permit excellent determination of alignment needs. Two pull lines at the caisson's top, situated on cross axes, can perform the alignment operation quickly. Where strong waves and current exist, this operation without proper equipment can be time consuming, and more serious, may result in an off vertical column leading to severe trouble later.

After floor contact is made, the caisson is lowered with penetration being made by its own weight. In this example, only one and one-half feet penetration resulted under 45,000 lb of buoyant weight, giving an initial bearing estimated at 22,500 lb per sq ft resistance. Thus, an extremely hard ocean floor was indicated. Penetration under top driving and with jetting proceeded without incident to terminal depth of about 135 ft through soil. The maximum drive effort occurred near the end of the operation when an extremely hard strata was encountered. Pump pressure approached 1500 psi, and the top driving load approached 475,000 lb plus caisson weight of 115,000 lb or 590,000 lb total.

Possible Improvements

Experience offers several suggestions that might facilitate speed, safety and convenience. The use of two feed lines appears adequate, and they are less troublesome than three; only one feed line might cause a non-uniformity of hydraulic energy distribution which could deliver an undesired directional characteristic to the path of the descending caisson.

A type of high pressure flexible tubing made of metal web and a rubber-like material would be preferred to steel hose for the surface manifold lines. Benefits would include time savings, increased safety and convenience. Such hose is available in 1½-in. ID, 2000 psi working pressure and 8000 psi burst strengths.

The vertical feed pipes should have couplings of the "bottleneck" or unitized type to better avoid clearance conflicts when passing through the hydraulic driving ring.

Mobile rigs have a high day cost; up to $8500 per day, or nearly $6 per min. Time spent in welding a large caisson translates into substantial rig expense. Hence, the length of caisson joints as rolled at the boiler works should be the maximum within the capacity of the rig limitations of either weight or length. Such a practice reduces the number of field welds needed. Further, the end dressing of the joints can be made favorably where the quantity of

weld metal deposit is minimized within stress requirements. The expensive time cost to weld ends as shown in Fig. 7 is only about 45 percent of that required in Fig. 8. In terms of dollars, the method shown in Fig. 7 will surrender a net rig time savings of $4000 for one string of 36-in. caisson of six 40-ft sections requiring five field welds. Strengthwise, the stress being vertical compression, the method in Fig. 7 is believed adequate.

Hydraulic Calculations

Since six-inch pump liners were in place, the acceptability of this size was checked by the following reasoning.

Annular velocity of at least 100 ft per min was desired to float displaced "cuttings" to the surface. This determined pump volumes. To utilize drilled hole openings in the ring without excessive erosion, a fluid velocity of 100 ft per min was considered maximum. Thus, with above pump volumes, the area for each hole is fixed. The number of holes was not permitted to cause an unsafe structural weakening of the jet ring.

Pump volume requirements follow:

$$G = \frac{Va(D^2-d^2)}{24.55} = \frac{100(38^2-36^2)}{24.55} = 587 \text{ gal per min}$$

Where:

G = 587 gal per min, pump volume required to assure 100 ft per min return velocity.

D = Diameter of the outer hole; this would be cut by jet ring to a nominal 37.125 in. – The value of 38 in. is used in the event of some washout. If washout is extreme, velocity will be slower, causing a fill-in and eventual equilibrium balance.

d = Diameter of the caisson – OD inches.

Va = Annular velocity of 100 ft per min desired.

The friction loss of 587 gal per min for surface connections is estimated at 44 psi. The friction loss through the three feed pipes of 2½-in. EUE is calculated. Each pipe carries 196 gal per min.

$$P = \frac{0.000061\ ML(G)^{1.86}}{D_p^{4.86}} = \frac{(0.000061)(9)(270)(196)^{1.86}}{(1.995)^{4.86}} = 94 \text{ psi}$$

Where:

P = Pressure drop through one of the three feed pipes, by one-third of the total gal per min.

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This would be 94 psi per each pipe, or a total of 282 psi for all three.

M = Fluid weight per gal, 9 lb per gal.

L = Length in ft of lines at terminal depth, see Fig. 6 at 270 ft.

G = Gal per min carried by each pipe.

D_p = ID of the tubing.

Losses through the return annulus are negligible. Therefore, with the exception of losses through the ring openings, the total friction drop expected is the sum of the foregoing, or 326 psi. The pumps with 6-in. liners were capable of putting up 1970 psi. This would leave a residual pressure capacity of 1644 psi available for use in overcoming friction drop at the drilled hole openings.

With drilled holes spotted on 6-in. centers around the ring, a total of 18 would be used, along with 3 additional for the weld ells, see Fig. 4, or a total of 21 openings. Continuing the calculations on the basis of a single opening, its fluid passage would be 28 gal per min. On the basis of unit fluid passage, its area is given by the following:

$$A = \left[\frac{MG^2}{12{,}031\ PC^2}\right]^{1/2} = \left[\frac{(9)\ (28)^2}{12{,}031\ (78)\ (0.80)^2}\right]^{1/2} =$$

0.1085 sq in. calculated

Where:

M = Fluid weight or 9 lb per gal.

G = Fluid, in gal per min through each nozzle, 28 gal per min.

P = Pressure drop at each nozzle, 78 psi (1644/21).

C = Orifice coefficient for drilled water courses.

A = Area, sq in. of each drilled hole.

Solving for diameter, gives 3/8 in. for the size of all 21 openings. Next calculate fluid velocity through the openings, given by:

$$V_n = \frac{0.32\ G}{A} = \frac{(0.32)\ (28)}{0.110} =$$

81.5 ft per second

Where:

V_n = Velocity through openings in ft per second.

G = Gal per min through openings.

A = Area of drilled 3/8 in. diameter openings.

Other Factors to Consider

Further considerations of importance exist relative to the contingency

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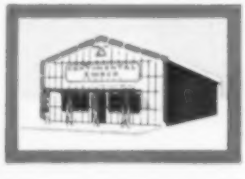

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of the caisson to either buckle or collapse when loaded by the powerful hydraulic driving ring.

To estimate the caisson's resistance to buckling induced by top loading, Eulers equation[2] is used.

$$P = \frac{\pi^2 E I}{4 L^2} =$$

$$\frac{(9.87)\ (30{,}000{,}000)\ (20{,}598)}{(4)\ (1512)^2} =$$

666,000 lb

Where:

π = 3.1416; π^2 = 9.870.

E = 30,000,000 psi.

I = Moment of Inertia, inches^4.

I = O.049087385 $(D^4 - d^4)$ = 20,598 in^4.

D = Outer diameter of caisson, 36 in.

d = Inner diameter of caisson, 33.50 in.

L = Length, in inches, of the caisson from the point of top load application down to its first point of fixity, frequently assumed to be 20 ft below ocean floor. From Fig. 6, L is taken at 126 ft = 1,512 in.

$$4 L^2 = 4 (1512)^2 =$$
$$(9.144)\ 10^6$$

To prevent buckling of the caisson, the calculated maximum top load is approximated at 666,000 lb driving force. This equation implicitly assumes that the column is exactly vertical; and that earth reaction forces acting vertically upward are of a uniform magnitude distributed against the circumferential face of the jet ring.

For the benefit of operating personnel on the job, a maximum operating load should be given to them. This would be obtained by applying to the calculated maximum of 666,000 lb, a safety factor selected in accordance with company operating policy. For purposes of convenience in extending this example, assume a safety factor of 1.333. Thus 500,000 lb would become the maximum actual load to be imposed. Where four 10-in. bore hydraulic driving cylinders are used to actuate the driving ring, the total pressure area is 314.16 sq in. Therefore, a maximum operating driving pressure calculates out at 1590 psi (500,00 ÷ 314.16). This pressure limitation applies only to buckling; similar information is also required to prevent collapse failure.

Collapse considerations were complicated by the fact that the driving slips consisted of 12 separate segments of a relatively small size, measuring 4 in. wide by 7½ in. long. These were

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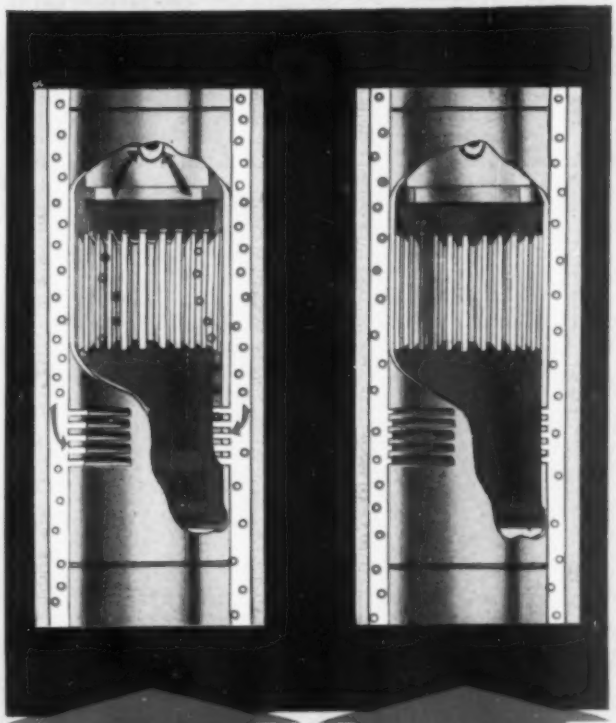

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equally spaced radially at six stations, in clusters of two, one above the other. Brief reflection indicates the difficulty of making a calculation that would estimate a critical slip pressure with good reliability. Some known past experience was utilized by an indirect calculation. It was known that a 30-in. by 1-in. wall caisson had successfully carried 2200 psi driving pressure without collapsing. By calculating the relative resistance to collapse of the two caissons, and drawing a comparative ratio, it appeared possible to then adjust the 2200 psi value to one of acceptable use.

The collapse resistance to uniform external pressure is given by[3]

$$S_t = 2P \frac{R^2}{R^2 - r^2}$$

Where:

S_t = psi, tensile proportional limit of the subject steel, taken at 35,000 psi.

P = psi, external uniform pressure.

R = Outer radius, inches.

r = Inner radius, inches.

For the 30-in. by 1-in. wall caisson, P = 2250 psi.

For the 36-in. by 1¼-in. wall caisson, P = 2320 psi.

The allowable driving pressure then would be:

$$\frac{2320(2200)}{2250} = 2270 \text{ psi}$$

gage pressure actuating the hydraulic driver.

Recapitulation of safe allowable gage limiting pressure shows 1590 psi for buckling and 2270 psi for collapse. Therefore, field personnel should be guided by the critical limit of 1590 psi for actual driving operations.

A further consideration applies to possibility of collapse of the jet ring under heavy upper end loading. Assuming that skin friction has been fully destroyed by high ascension velocities, then the maximum load that would occur on the ring would be 100 percent of that imposed at the top. A calculation to determine this limit follows:

$$La = \frac{Lc\,(C + Pi)}{N} =$$

$$\frac{(34.5)\,(3.14)\,(10{,}140 + 1000)}{2.00} =$$

602,000 lb

Where:

La = Allowable end load, pounds.

Lc = Circumferential length of ring, inches.

C = Collapse resistance, psi, API data, 10,140 psi.

Pi = Internal pump fluid pressure opposing external collapsing pressure, psi taken at 1000 psi.

N = Safety factor, taken at 2.00 to adjust for inequalities of mechanical pressure.

Since 500,000 lb was the critical limit imposed by buckling, the ring performance appears safe.

The following conclusions are believed applicable:

1. Where adequate columnar stiffness exists, substantial side stresses can be exerted by and in the reaction moment, below the ocean floor, against the earth.
2. These side stresses must be kept below the critical earth strength.
3. This can be accomplished by adequate depth penetration.
4. For rigs equipped with hydraulic caisson driving machinery, the use of a jet ring provides a substantial aid in facilitating penetration.
5. Their cost is nominal and their operational use does not impose any great problem.
6. Their benefits can be substantial and with proper construction strength in fabrication, the probability of their failure can be made remote.

References

1. Hydraulic Equations used were obtained from *Hydraulics in Rotary Drilling*, Bulletin No. 1-A Revised April 1954, Hughes Tool Company.
2. Euler's Column Equation, from the text *Resistance of Materials* by Fred B. Seely, Second Edition, 1935. Page 189.
3. Same as No. 2 above, Page 360. ★ ★ ★

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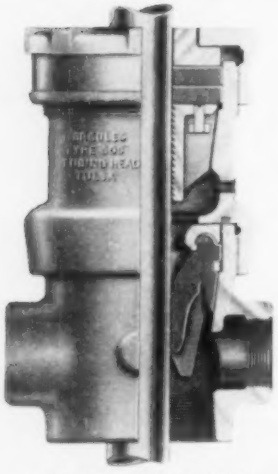

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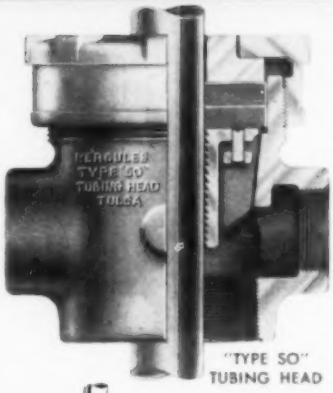

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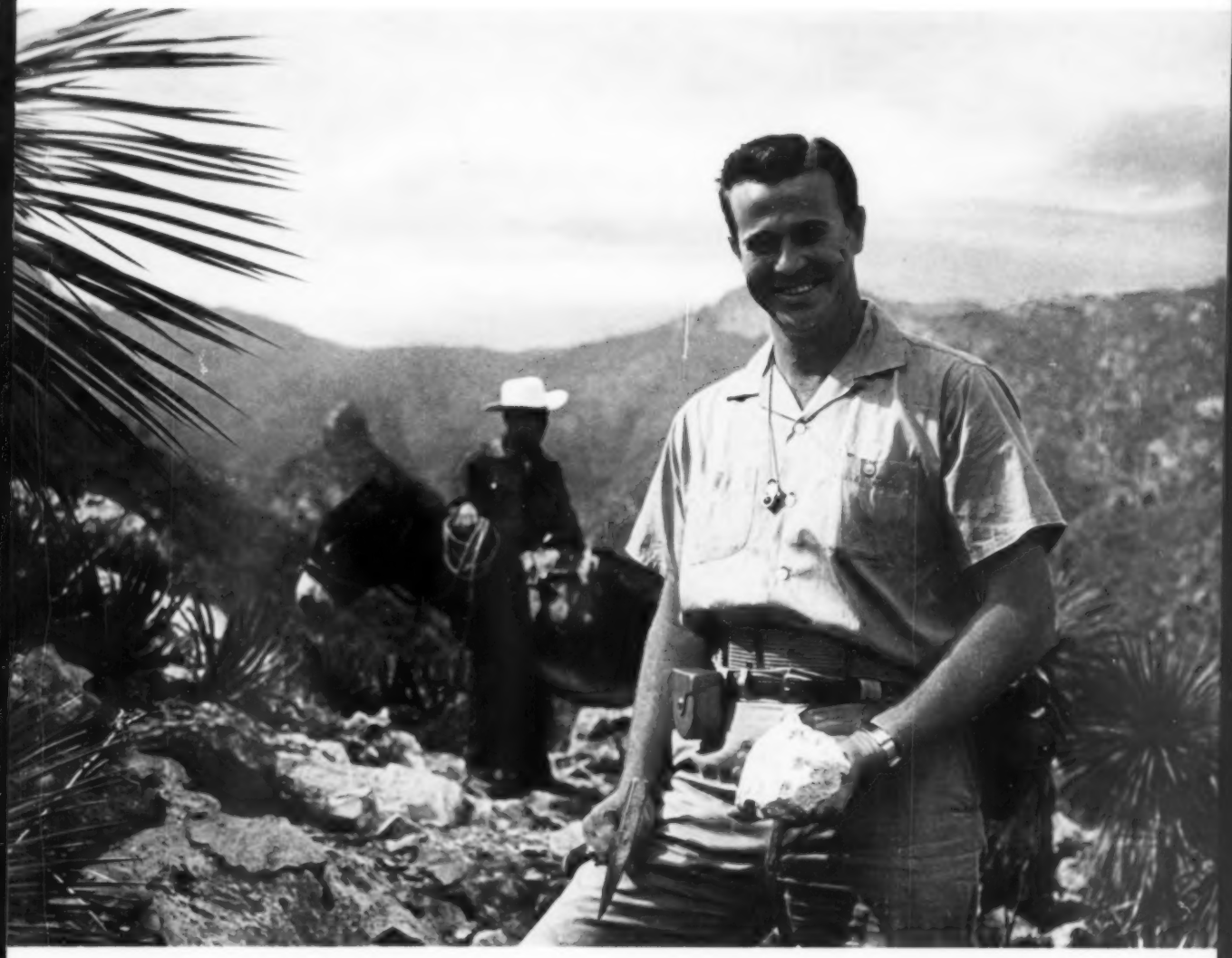

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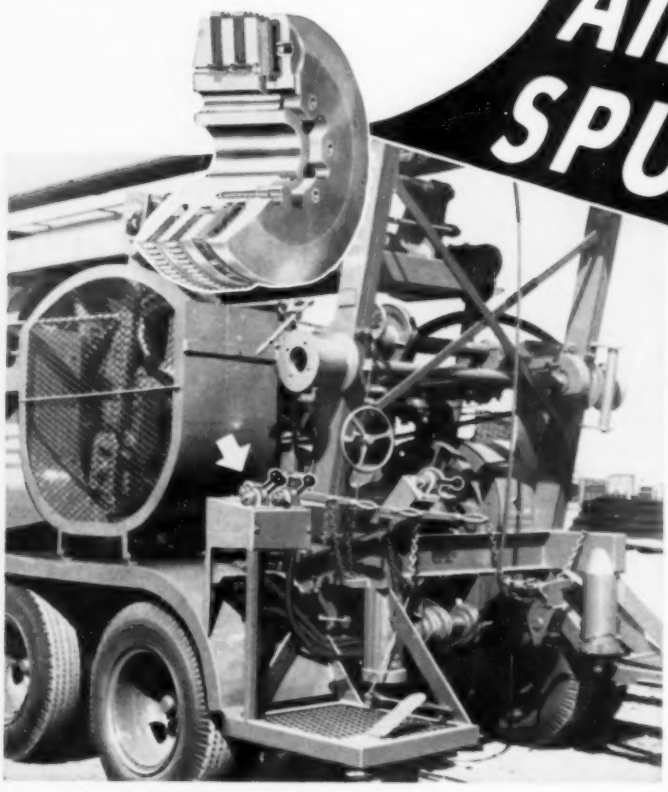

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Humble helicopter picks up crew ready to go ashore from the company's tender ST-7 in a routine flight of "Offshore Airlift."

In 1956, 85,185 passengers carried by helicopters in Humble's . . .

P 372.4

Offshore Airlift

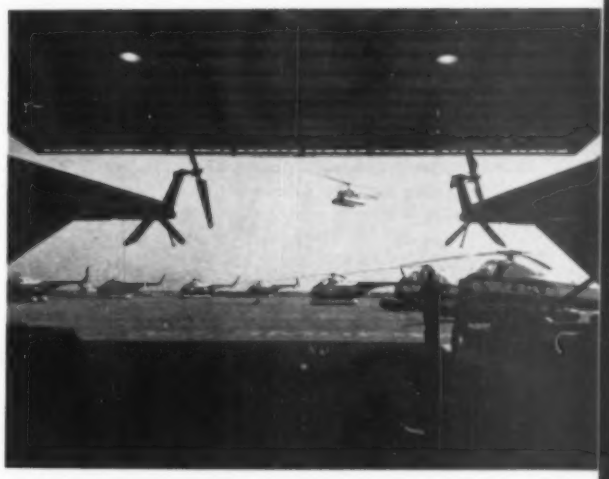
A versatile workhorse, the helicopter helps keep Humble in the race for offshore oil by ferrying men, materials to rigs in Gulf

IT was a typical November morning at Humble's Grand Isle heliport: the air was clean and cold. A slight, erect figure in a black overcoat stood on the asphalt apron of the hanger. With his bushy gray mustache, he might have been mistaken for a college professor.

Silently, he scanned the horizon. In the distance, drilling rigs sprouted like water plants from the blue water of the Gulf of Mexico. Inside the hanger, mechanics moved about their mid-morning duties.

Outside, half a dozen men carrying suitcases passed before the visitor on their way to a red-and-white striped helicopter on the far side of the landing ramp. Leading them was a pilot, marked by his bright-yellow Mae West life jacket, clipboard and mail sack. Other men were crawling from a helicopter that had just nestled down on its silver pontoons, its rotors still spinning. Already it was being refueled with high-octane gasoline. In a faint Russian accent, the visitor broke the silence.

Article taken from *Humble Way*, March-April 1957, published by the Humble Oil & Refining Company, Houston, Texas, and reproduced here by special permission.



Busy Grand Isle heliport, center of Humble's offshore helicopter operations. Drilling crews with suitcases board whirlybird being readied for takeoff, while Bell 'copter comes in for landing.

Two new helicopters enroute to Humble's Grand Isle base bringing the total to 15 whirlybirds. These are new Sikorsky-58 models which can carry 12 men 150 miles from home base and back.

Humble's heliport, adjacent to district offices at Grand Isle. In February, 12,103 passengers were shuttled to offshore locations. Whirlybird flock has grown from 2 in 1954 to 15.

Weighing in passenger and luggage in waiting room at Grand Isle terminal where crews assemble for offshore flights.

"This," he said quietly, "is the outstanding helicopter operation of its type in the world today."

The man wasn't just talking through his narrow-brimmed, black fedora. He was the great aviation pioneer, the man who built and flew the world's first really workable helicopter. This man was Igor Ivanovich Sikorsky.

In civilian passengers carried, Humble's 'round-the-clock helicopter ferry operation in Louisiana bows to none. The only other U. S. contender is New York Airways, which last year shuttled 33,000 passengers between three New York City-area airports. Sabena of Belgium, flying between eight cities of Europe, was only a little busier handling 34,000 persons.

Humble's airlift to its 15 offshore drilling rigs is two and one-half times as large. In 1956, its helicopters carried 85,185 passengers. There were 38,558 flights, a total of 8498 injury-free flying hours.

Humble's Whirlybird Fleet

The February delivery of two new 12-passenger Sikorsky-58's, straight off Sikorsky's Bridgeport, Connecticut, assembly line, brings Humble's whirlybird flock to 13. Two more S-58's were scheduled for recent delivery. They join six eight-place S-55's and five three-place Bell helicopters. In harness together, the two larger classes of ships are the work-horses of the ferry service.

If the S-58 and S-55 are the work-horses, the little Bell is a versatile pony. In three hours of Bell-hopping, District Superintendent I. D. ("Slim") Wafer can cover a route that would take 10 to 12 hours by boat. In a Bell, the special sensation of flying in a helicopter is accentuated. You are almost completely enclosed in a clear plastic bubble. The takeoff is quick as a hiccup; you want to grab something — and usually do. One man said it is "like riding a pogo stick in a giant fish bowl."

Pioneer Operation

The Grand Isle helicopter operation is a pioneer effort in rotary wing aviation. For the first time, the helicopter is performing a large-scale mission that is economically justified. It has lived up to its advance billing by operating just like an offshore bus line.

Schedules are strict. Helicopters take off at times like 6:29, 7:05 and 8:15, return at times like 8:23, 9:18 and 1:22. Once, just to keep the airlift on schedule, C. M. Scholes, head of Humble's aviation transportation division, motored all night from Houston to Grand Isle to deliver a tiny gasket and have an S-55 safely in the air the next morning. "Gasket wasn't worth three cents," Scholes remembers.

To the men who work in the Gulf, the long, torturous boat trips to offshore locations are good riddance. One trip, four and one-half hours by boat, is only 35 minutes by S-55. In the S-58, it is only 30. The oil worker remembers the green-gilled feeling called seasickness. He remembers, too, 10 days at a stretch on the LST or platform — being away from home and family.

Three years ago, a storm might have meant accident and long delays reaching a doctor. During last season's Hurricane Flossie, however, crews on Humble rigs were hurried to shore with time to spare. When the storm hit, the whirlybirds, with wings removed, were huddling together inside the hangar like so many weathered-in sparrows.

Typical Helicopter Trip

Helicopter travel charms all who try it. Even the ex-landlubbers, who make up the bulk of drilling crews. Like Mr. Sikorsky did last November, let's take a typical helicopter trip out into the Gulf. We get up early, eat, and arrive at the heliport at 6:30 a.m. — with plenty of time to check in on the 7:05 flight to Rig No. 36 and ST-10. That's 22 boat miles offshore.

In a spacious waiting room, toolpushers, drillers, roustabouts mill about with an easy nonchalance never seen at Idlewild or Washington National airports. You step on the scale and record your weight on a pad marked "ST-10." Soon the pilot comes in, speaks to the veteran passengers and tallies up his cargo. Then turning, he says something like "All offshore that're goin' offshore. ST-10," and walks through the hanger to his 'copter.

You follow. Inside the cabin of one of the big, new S-58's, you get tangled up in an orange life jacket. A 200-pounder in a hard hat helps out; shows you how to buckle the seat belt. Just then, there is a buzzing sound followed by a croaking cough; then the 1525-hp Wright-Cyclone engine begins to purr with power. The main rotor overhead starts to turn, slowly at first. Soon it is popping rhythmically like a hundred sheets in a high wind.

After five minutes' warm-up the noise suddenly gets a little louder, the vibration a little greater. The machine rocks, then begins to rise. It is now you get **The Helicopter Feeling.** You are exhilarated; it's like a ferris wheel ride, but better. You can't help but smile.

The helicopter noses forward and moves out, like a sprinter getting away from his starting blocks. You are being swept along through the air as if in a basket at the end of a long rope. Up, up you go until the landing strip is but a small black patch. You look at your wristwatch. 7:05. Right on schedule.

At 600 ft, the ship levels off, passes over the sandy Grand Isle beach and hums at 80 mph out over the blue of the Gulf, crossing paths with a boat slowly ploughing the whitecaps below. The rotor overhead spins lazily like an old-fashioned ceiling fan. Those four rotor blades, made completely of aluminum and waxed to a high gloss, are the heart of the helicopter. Each is 27 ft long, yet weighs but 165 lb. They revolve only about 270 rpm, but are traveling 400-500 miles an hour at the tips.

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THE WEATHERFORD TECHNIQUE

Elevated landing platforms support Bell 47-G's during loading. Idea here is to eliminate danger of buzzing tail prop.

Rigid maintenance checks by 22 skilled mechanics keep Humble helicopters air-worthy high percentage of time, protect safety record: In 1956, there were 38,000 flights, no mishaps.

Exactly 14 minutes later, the helicopter banks sharply to allow a view of Rig No. 36 and the converted LST with a flat, modified square area at one end. Nobody has to tell you. That tiny yellow bull's-eye is the landing spot.

Before fear can set in, the ship is hovering above the target and settling down to the gently rolling deck. Helicopter landing is marshmallow soft.

Another glance at your watch confirms that the offshore airlift is right on time. Within moments, your cabinmates have alighted and others have crawled on with their suitcases — talk about life on the land going out, talk about life at sea coming in. The pilot exchanges mail sacks with a seaman standing by. Then again, the big noise: again, up and away; again, you smile.

Too soon, you are back at the heliport. As you flutter down, the air seems rubbery, bouncing you a little, then lifting you up. Now you loosen the safety belt, shed the life jacket and step cautiously from the helicopter as the rotor spins above. It is 7:40. Just as the schedule read, it was 15 minutes each way, five minutes in between.

Throughout your first ride, you wondered how any human could fly this frantically flapping machine. So you meet Chief Pilot Gus Johnson, who strolls out to an S-55 and shows how.

"The helicopter," says Gus, "has to be babied more than the fixed wing aircraft. Take your hands off these controls for any length of time and the thing is flopping all over the sky." The way he explains it, you figure the 'copter pilot is a pretty busy individual.

The Men Who Drive

Humble helicopters at Grand Isle are piloted by 21 men working for Rotor-Aids, Inc., a helicopter contract service headquartered in Ventura, California. A pilot works an 8-hr shift four days, an 8-hr shift four nights and then is off four days.

To pilot a helicopter for Humble, you need a commercial pilot's license with helicopter rating and a minimum of 750 hours of helicopter time. At Grand Isle, Rotor-Aids has 10 pilots with more than 2000 hours. Three of every four were service helicopter pilots.

The helicopter pilot navigates visually, by the landscape, radio and compass. At Grand Isle, they know the Continental Shelf like their own backyard — only on three occasions in two years have pilots had to turn back because of faulty navigation. That's not bad when you consider that average Gulf visibility is 7 to 10 miles, that some of the rigs sit as far away as 35 miles.

Safe Practices

Fog is the worst enemy. Military pilots boast that the helicopter can fly "even when the birds are walking," but bad weather clips the wings of the Humble whirlybird fleet. Anything under three miles visibility and a 500-ft ceiling puts the tortoise-like boats back into temporary service. That happens about once a month from October through March.

In air transport, safety is king. Humble's helicopter system at Grand Isle is working proof. In no case is a load limit exceeded: An extra 'copter is sent along to carry that extra man. A crewman always stands by with a fire extinguisher when a helicopter cranks up. All craft, of course, are equipped to set down on land or water. The S-58's carry a specially-designed amphibious gear which allows landing on rubber floats or retractable wheels. Landings with power off are practiced regularly. Extra fuel is staked out on a lonely beach — the half-way mark to a rig 35 miles away.

There's no daredevil stuff by the pilots. They take the safe, easy way every time. They have a saying: "There are no old, bold pilots."

A common question is "What would happen if the engine stops?" The answer is: Autorotation. This means if the engine fails, its clutching mechanism connected to the rotor is automatically disengaged. The blades continue to rotate due to air pressure exerted against them as the craft slowly descends.

Just before landing, the helicopter hovers momentarily in a unique phenomenon. About six feet up, the rotor downwash bounces back and provides a cushion of air to land on. This same rotor wash has pushed ashore a sailboat stranded on a windless lake and thrashed a ripe Texas pecan crop to the ground from overhead.

Helicopter Maintenance

Of all the airborne craft, the helicopter owns the best safety record. In support, not one person has ever been hurt in a Humble-owned machine. A major slice of the credit for this outstanding record goes to the 22 mechanics of the maintenance group. Last year, they kept four of Humble's six S-55's available 100 percent of the time; five of them available 87 percent

of the time. All six were available 17 percent of the time.

Painstaking mechanical checks made this possible. Every craft undergoes a thorough examination daily. After 50 flying hours, it is wheeled into the hangar. There it is checked from stem to stern. The main checklist contains 257 items. Parts are replaced: Maximum use of the helicopter's components is not the goal. An engine analyzer detects motor flows, like a cardiograph listens for a heart murmur. Extra engines, all built up, stand ready. When the helicopter goes back into service, it is practically as good as the day it left the factory.

Engines are recommended for complete overhaul at 600 flying hours. Humble has it done at 480. The S-55 engine, a 600-hp Pratt-Whitney, is trucked all the way to Houston. There, more manhours are spent rebuilding the engine than it spends in the air. The S-58 engine will return to a New Jersey factory for overhaul. All told, the Humble helicopter spends 5½ hours on the ground in checking and repair, to every one in the air.

What's Ahead

The future of the helicopter with Humble seems secure. The S-58's went into service March 1, and two more like them arrived in April. It should surprise nobody if the offshore airlift carries 150,000 passengers in 1957. And since the S-58 carries cargo equipment, it may not be unusual to see a whirlybird flying offshore with a pipe or other oilfield equipment in its talons.

The helicopter, with all its talents, is not perfect. Even Lindbergh's 1927-vintage "Spirit of St. Louis" was faster and rangier than any helicopter Humble owns today. But for specialized tasks such as at Grand Isle, it's hard to beat an "eggbeater."

Aviation Chief Charlie Scholes realizes this better than most. "This thing is no toy," he says. "We are carrying the life's pulse of our operating and supervisory personnel. Mr. Sikorsky is right: 'It's the outstanding operation of its kind in the world.'"

Some interesting facts about...

Offshore Application of HELICOPTERS

About 30 whirlybirds fly men and materials to and from offshore locations in the Gulf of Mexico

Oustide of the military, the use of helicopters for offshore oil and gas development comprises the biggest whirlybird operation anywhere. One company, Humble, in 1956, carried 85,185 passengers by helicopter in 38,558 flights. This is 2½ times the number of passengers carried by New York Airways that year between three New York City airports. Sabena Belgian World Airlines carried only 34,000 passengers between eight European cities by helicopters. Humble, with 15 helicopters, operates about half the offshore whirlybird fleet.

Only a few years ago, the helicopter was considered a luxury item that most offshore operators looked upon with considerable doubt. The few units in operation were reserved primarily for emergencies and supervisory personnel. But the 'copter proved its worth in the costly offshore operation by affording speedy, comfortable and safe transportation about the open Gulf waters.

It has since grown from its previous luxury classification to one of almost necessity. Not only has it served as a big factor in morale, but it has performed numerous tasks otherwise not possible. Precious time is saved (and money, too) and in emergencies, the helicopter is a valuable asset. Injured and sick crewmen on offshore structures can be taken directly to hospitals in little time; during impending hurricanes, all personnel can be evacuated from offshore locations with a mini-

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mum of advance warning of the storm's approach.

Offshore Helicopter Operation

The offshore helicopter fleet varies as to ownership and operation. Two companies own and operate their own craft; Humble owns its larger Sikorsky helicopters, but contracts for their operation with Rotor-Aids, Inc., of Ventura, California, who also own and operate for Humble five Bell 47-G's under contract; and Petroleum Helicopters of Lafayette, Louisiana, who own their own craft and serve various offshore operators on a contract basis.

Magnolia Petroleum Company of Dallas, Texas, was the first major operator to buy and operate its own helicopter. From its base at the Jefferson County (Texas) Airport, supervisory personnel are carried to two locations. One rig is located in the Sabine Pass area. From the home base to the Sabine Pass heliport is 22 miles. Traffic is primarily from Sabine Pass to the rig and back. The helicopter is used exclusively by executives, supervisors and drilling specialists. Because of insurance coverage, crewmen are carried only in cases of emergency. Except for special cases, one flight per week is scheduled to change toolpushers. The second Magnolia air lift is to an offshore rig operating 22 miles off the coast of Cameron Parish, Louisiana. Flights to this rig are on a special call basis only.

Statistics on Humble's helicopter operations are vividly presented in the preceeding report. Rotor-Aids employs 23 pilots to serve Humble's needs to fly both the oil company's big S-55's and S-58's, and its own 5 Bell 47-G's. With a fleet now totaling 15 helicopters, undoubtedly the number of passengers to be carried this year will far exceed the 85,185 transported to Humble's offshore operations last year.

From its main base at Lafayette, Louisiana, Petroleum Helicopters operate from many points along the Texas-Louisiana coast. The company has been in operation for eight years and has logged a staggering 40,000 hours of helicopter flight. Typical of present offshore operations are figures covering nine months, from May 1, 1956, to January 31, 1957, when 4945 hours were logged, for an average of about 550 hours per month. Petroleum Helicopters presently has six Bells regularly contracted for offshore work, but at times has used 10 Bells. They also own and/or operate four Sikorsky S-55's and one S-58. Records show that they transport about 12,000 passengers per year, or about 700,000 passenger miles per year. In its Texas-Louisiana operation, Petroleum Helicopters carry about 40 emergency cases annually. Arrangements have been made for heliports at the following hospitals: Oschner Clinic in New Orleans; Our Lady of the Sea at Golden Meadows; Morgan City Hospital, and Lake Charles Memorial Hospital.

Petroleum Helicopters contracts with the following major offshore operators: Gulf Oil Corporation, Continental Oil Company; Pan American Petroleum Corporation, and Superior Oil Company.

The company also operates helicopters for petroleum exploration in Columbia, South America. In all, it employs 70 maintenance men, 50 pilots and 15 administrators.

John Mecom with headquarters at Hitchcock, Texas, near Galveston, is reported to operate three smaller helicopters to serve drilling and producing operations.

There are perhaps other helicopter operations along the Gulf Coast serving the petroleum industry. This report does not cover those used in geophysical exploration in the marshes. Helicopters have grown from an infant into a strong transport arm of the offshore petroleum industry, and undoubtedly will continue to grow in size and importance to maintain its position as the largest single user of helicopters outside the military. ★ ★ ★

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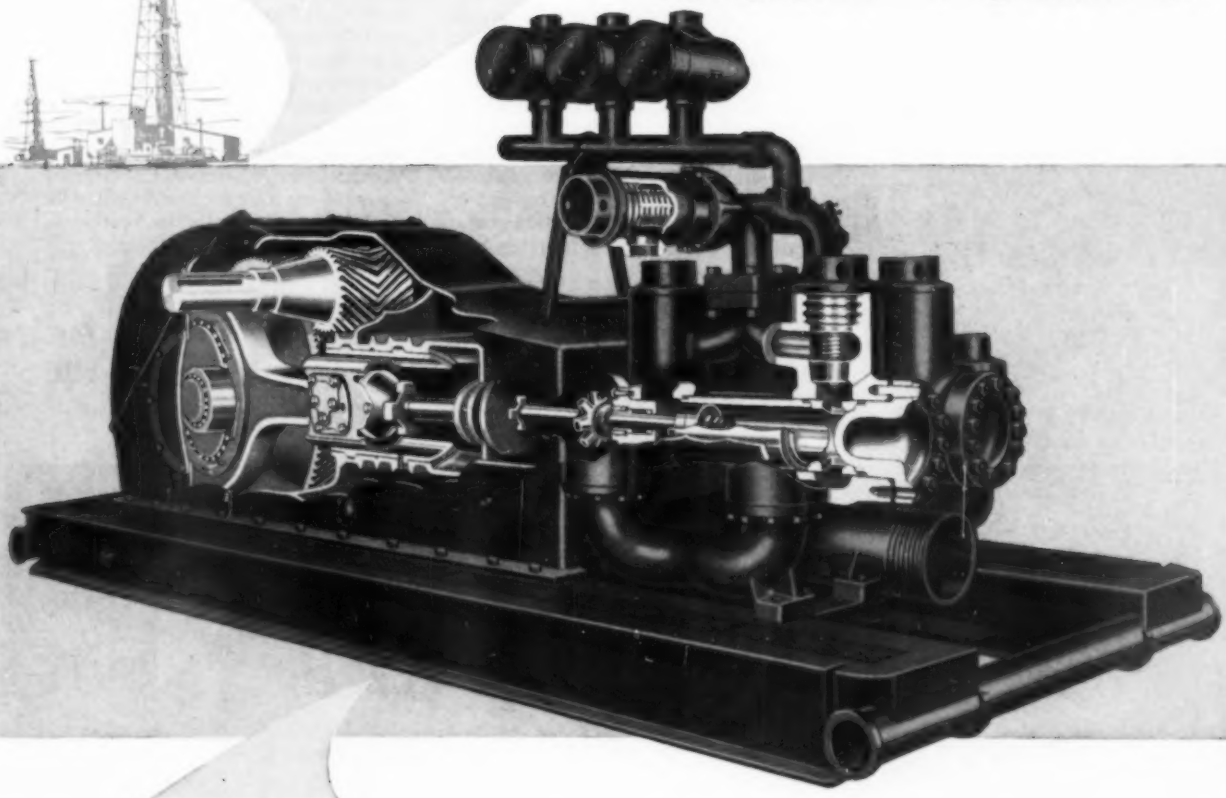

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PERSIAN GULF'S FIRST OFFSHORE OIL

FIRST offshore oil production in the Middle East, from the Safaniya field in the Persian Gulf, has been announced by the Arabian American Oil Company. Initial flow is 50,000 bbl per calendar day, with expansion to 177,000 bbl per calendar day scheduled by mid-1958.

Safaniya is located off the Saudi Arabian mainland in the northern Persian Gulf, south of Kuwait and the Neutral Zone and about 180 miles north of Dhahran. The field was discovered in 1951. It is believed to be the largest marine offshore field to be proved as yet in either hemisphere. It extends more than 10 miles offshore and is about 20 miles long. Some 70,000 acres are believed to be productive.

Safaniya production is from two producing zones in the Bahrain sand formation (middle Cretaceous) at a depth of 5000 to 6000 ft. So far, 22 wells have been completed, two of them onshore and the other 20 offshore. Crude from this field is sweet and of 27 deg API gravity, heavier than other Arabian crudes. It has a relatively high yield of fuel oil, for which demand has been growing, especially in Western Europe. All other Aramco fields produce sour crudes.

Crude oil from Safaniya is flowing southward through a 140-mile 22-in. pipeline both to the refinery and to the crude oil shipping terminal at Ras Tanura. The Japanese tanker Nissyo Maru loaded the first shipment of Safaniya oil at Ras Tanura about May 5.

Work is now being completed on Safaniya Well No. 23. It is expected that 32 wells will be drilled by mid-1958. These offshore wells are drilled from steel platforms on pilings driven in the Gulf floor. Power is supplied by a 174-ft diesel-electric drilling barge, nicknamed the "Queen Mary" because of its size. The barge was built in 1948 for Creole Petroleum Corporation, was purchased by Aramco in 1951, and was towed from Lake Maracaibo, Venezuela, to the Persian Gulf. Drilling crews are composed solely of Saudi Arabs except for their American supervisor.

Aramco taps its 70,000 acre Safaniya field to the tune of 50,000 bbl per day from 22 wells

Arabian American Oil Company drilling rig at work in the immense Safaniya field. Discovered in 1951, the field wells are being drilled one by one.

Single structure platforms such as this are used in the development of Safaniya field. This platform, used to drill Well No. 21, is two days from completion.

Present cost of the Safaniya field facilities is estimated at $21,000,000, including $11,000,000 for the pipeline to Ras Tanura. Total cost includes a pier, a gas-oil separator plant, and a pump station. Also included in the cost is a bulk plant for the distribution of oil products in northeastern Saudi Arabia.

Crude is gathered through a 12-mile 16-in. submarine pipeline through the center of the producing area. Some 40 miles of 6-in. flowlines connect the individual wells. Some 21,000 tons of pipe are involved in the entire Aramco pipeline system. Pipe was purchased in Western Europe where most of the company's production is sold.

Safaniya could well become the world's largest crude oil separating point, since all of its scheduled producing wells will feed into a single GOSP (gas-oil separator plant) location. Other fields might far surpass this one in production, but they usually are serviced by several GOSP's at different locations.

Transporting the offshore crude into the Safaniya-Ras Tanura pipeline required the opening of approximately 42 main valves in the oil stream at wells, flowline platforms, traps and spheroids. Probably another 100 smaller valves in the GOSP area also had to be opened and checked before the oil could flow.

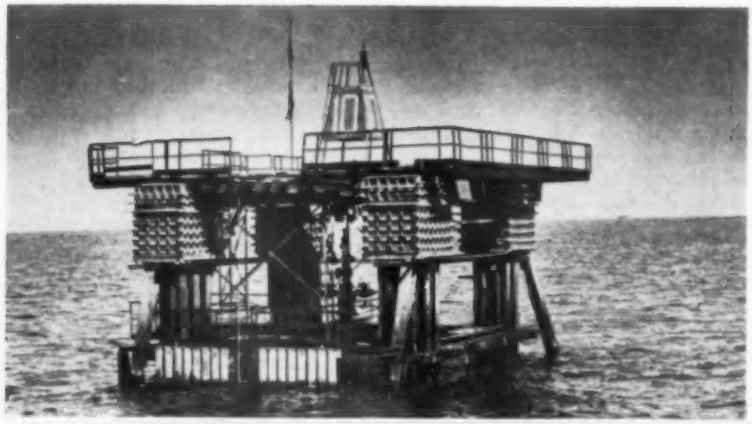
Materials and facilities are on hand to increase production to 115,000 bbl per day by July 1, 1957. Engineering plans are completed, purchase orders have been approved, and most of the materials are on order to raise production to 175,000 bbl per day by July, 1958.

A temporary diesel-powered pumping unit is being used to maintain the 50,000 bbl per day level. Three 1000-hp combustion gas turbine driven pumps will be required at Safaniya to reach the 115,000 bbl per day output by mid-year. For the 175,000 bbl per day production rate, the mid-point Khursaniyah booster pump station with four 1000-hp pumps will have to be installed, new wells and flowlines completed, and an additional pump installed at Safaniya. ★ ★ ★

Derrick man on this offshore drilling crew, like all other drilling personnel, is Saudi Arab. Only the supervisor is an American.

Platform and barge combination have drilled the 20-odd wells in this prolific field, about 10 miles wide and extending 20 miles seaward from the Persian Gulf shore.

Deck of Aramco's drilling barge, the "Queen Mary." The 174-ft long barge was purchased from Creole Petroleum Company operating in Venezuela.



Production platform in the Safaniya field, believed to be the largest offshore oil field anywhere. Only 22 wells are producing 50,000 bbl of 27 deg crude per day.

Helicopter shuttle service to transport men and materials to offshore locations can be made in fog and at night by means of a new electronic navigator system.

"Electronic road map" is . . .

Newest Helicopter Offshore Navigation Aid

40-lb instrument permits blind flying in offshore operations with precision accuracy in 100-mile range

AN "electronic road map" navigational system has been successfully adapted to enable a helicopter pilot operating in offshore oil areas to take off, fly to any spot inside a 100-mile area, and land safely without looking outside the helicopter cabin.

The "self contained instrument landing system" was revealed in a three-day series of demonstration flights as a joint operation of Bendix Aviation Corporation's Pacific Division and Bell Helicopter Corporation. The demonstrations, at Bell's plant near Fort Worth, Texas, culminated a year-long research project undertaken to make it possible to operate helicopters in remote areas at night or in weather requiring instrument flight.

In existing helicopter operations such as offshore shuttle services, the immediate application of the system could mean increasing the percentage of flight completions to nearly 100 percent.

The blind-flight helicopter system combines a Bendix-Decca navigator, Bendix Sonic altimeter, an improved attitude display and a glide path indicator. It is not limited to offshore helicopter work, but can be used for land and water navigation as well.

It is practical to completely blanket an entire geographical area with the new navigational system, which can be used by everyone within the area with a receiving unit. Potential oil industry applications include all types of exploration surveys, both inshore and offshore. In seismic surveys, for example, the system enables the crew to follow a predetermined pattern over land or water with a high degree of accuracy.

What it is. Essentially, the Bendix-Decca system consists of low-frequency ground wave radio signals transmitted from a chain of a master and two or more slave stations on the ground, and received by instruments in the aircraft, boat, automobile or even portable back-packs.

The master and slave stations transmit a pattern of stationary waves on different frequencies that occupy precisely known and stable geographical positions, forming navigational position lines of "electronic highways."

Position lines, technically described as phase relationships between these various wave fronts, are detected by receivers and the position information is computed and then displayed by meters or by a plotting board. The plotting board consists of a stationary navigation chart of the area and a moving pen that tracks the position at all times.

The airborne receiving unit weighs only 40 lb and is not restricted to line-of-sight reception. It is used to pinpoint the helicopter's location in an area with 25-ft accuracy, and also helps provide other necessary flight information. This accuracy would enable helicopters to fly at night from shore to rig under normal atmospheric conditions.

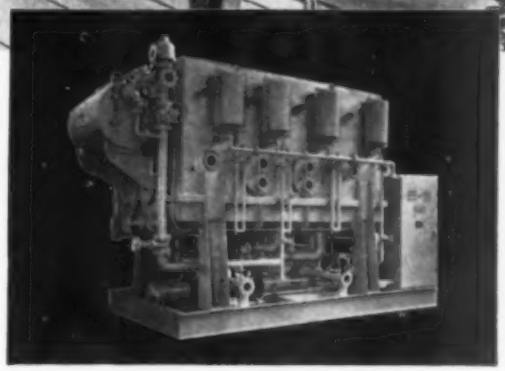
A feature of the electronic road map system is its absolute repeatability. As an example, a helicopter pilot flying to a rig operating 50 miles offshore can precisely retrace his flight day or night by following the route previously marked on the plotting board chart. Pilots can fly the pen and follow the navigation-position lines displayed on the board, deviating from one line or direction to another as necessary, much in the manner a motorist follows a road map to go from one city to another.

Obstacle information is important to the helicopter pilot for certain blind-flight application, since he usually flies within 1000 ft of the ground. A sensing instrument is needed, the Bendix engineers said, to present ground obstacle information to the pilot before absolute blind-flight operations are possible in remote areas.

Although the Bendix-Decca system does not provide ground-obstacle information itself, provision is made for displaying this data. The remote area in which the system is to be used must first be mapped, and ground obstacles — located by a separate survey geographically or by visual flight reconnaissance — can be charted on the plotting board sheets. In this way pilots can fly the stylus around known obstacles shown on the plotting board.

The Offshore Company **cuts fresh water costs** *aboard Rigs 54 and 55 with* **Cleaver-Brooks waste-heat evaporators**

The Offshore Company reports, "Cleaver-Brooks waste-heat evaporators aboard our mobile rigs *54 and 55* are producing 1000 gallons of fresh water per hour when drilling. The evaporators are operated at low cost from the waste heat of diesels. The two units have operated continuously without interruption for scale removal since August, 1956, when they were placed in service."



This is a typical 1000 gph, four-stage, waste-heat evaporator — installed in the holds of both The Offshore Company's rigs. Fresh water capacity of Cleaver-Brooks waste-heat evaporators is in direct proportion to diesel engine horsepower.

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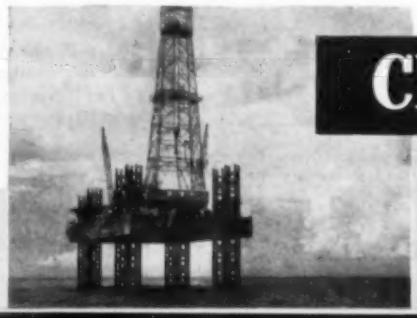

One of the two new Offshore Company rigs. Units are in service in the Vermillion Area and Galveston Area of the Gulf of Mexico. Three 875-hp diesels supply d-c power and two 450-hp diesels supply a-c power.

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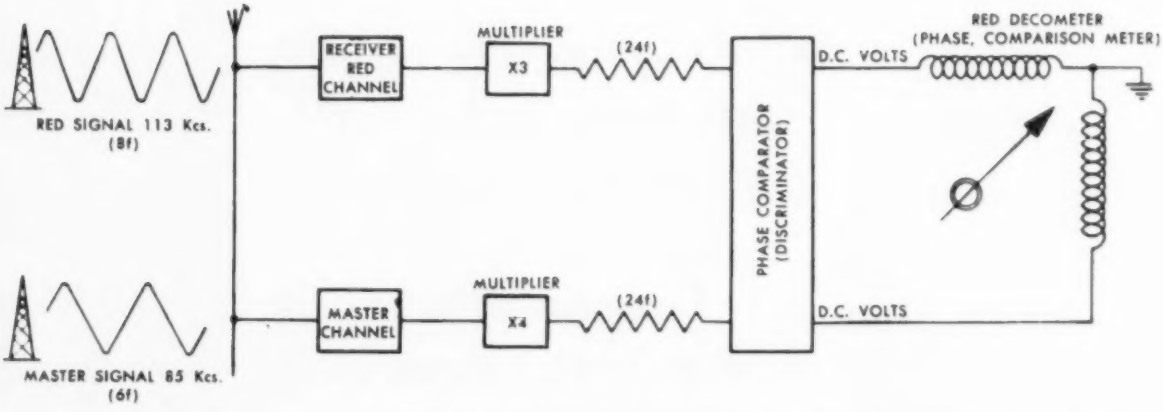


Basic idea of system involves one master transmitter and two or more slave stations transmitting on predetermined low frequencies. The phase comparison is indicated in the aircraft and plotted on a chart.

How it works. This new navigator system is based on the phase comparison of continuous wave transmissions from one master and two or more slave stations located accurately on land. Usually, the slave stations are deployed in star formation at distances of 70 to 100 miles from the master station. But, neither symmetry nor distance is critical.

These stations operate in the 100-kilocycle band. Transmissions from the stations bear a simple harmonic relationship and those from each slave are phase locked to the master transmission. By this means, overlapping phase patterns are produced between the master and each slave, which patterns form an omni-directional navigational grid in space. The grid is in fact comprised of hyperbolae or lines of constant phase difference between transmissions from the master and slave stations.

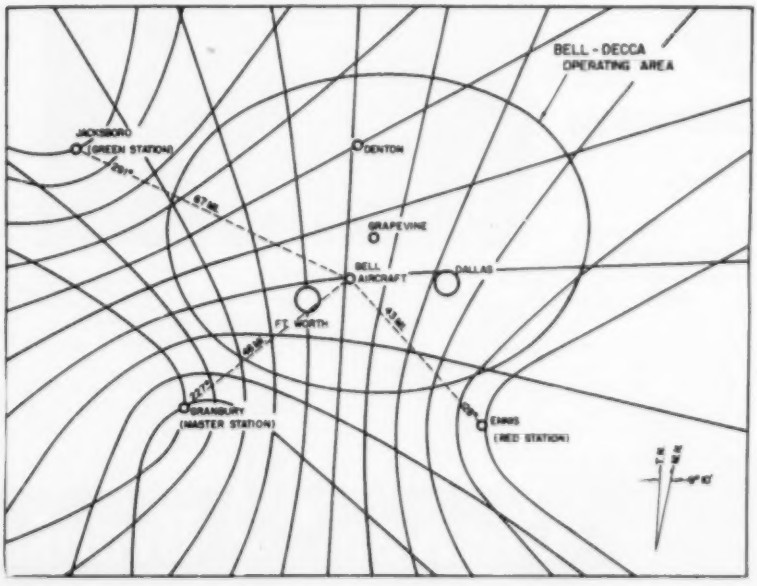
To avoid interference, each station transmits on a different frequency. For example, the master can operate on 85 kc, one slave on 113.3 kc, another slave on 127.5 kc, and a third on 70.8 kc. This frequency relationship is based on a fundamental frequency "F" which, in the case just related, is 14.17 kc. The master, therefore, transmits on 6 F, the first slave on 8 F, another on 9 F, and the third on 5 F.

The received signals are subsequently multiplied in such a manner that a common frequency is produced: The master signal is multiplied by 4, the first slave station frequency by 3 (6 F $\times$ 4; and 8 F $\times$ 3) produce a comparison frequency of 24 F. This comparison frequency, in the case above, corresponds to 340 kc, and since the wave fronts are approaching from opposite directions sychronously, the in-phase points will correspond to half a wave length. The interval between these in-phase positions is called a Decca "lane." For convenience, these lanes are grouped into "zones" and the number of lanes per zone is related to the comparison frequency of each pair of stations. The zone width, however, is constant, being related to the fundamental frequency F.

When the phase comparison has been effected in the aircraft receiver, the resultant is displayed on a meter known as a Decometer. Two or three of these meters are provided on the helicopter instrument panel, depending upon the number of slave stations required to cover the area involved. As the aircraft flies through the area covered, these meters will indicate accurately its position in the pattern.

In practice, the meters may either be set to known coordinates before take-off, or may be set later using lane identification transmissions which occur automatically each minute on the minute. By this means, a course pattern which corresponds in width to a zone, is radiated to enable the actual lane in which the aircraft is located to be identified. This facility allows the accuracy of the Decometer readings to be confirmed at any time during flight and provides an additional check on the functioning of the system.

The "electronic road map" navigational system was developed originally by Decca Navigation Company, Ltd., of England, and is being built for use in this country by Bendix-Pacific. ★



Hyperbolic space grid is formed by transmissions from known ground stations. This shows the Decca lanes in the Ft. Worth, Texas, area where the new navigation system was demonstrated at the Bell Helicopter Corporation plant.

7 keys to production stimulation

SANDOIL

VIS-O-FRAC

SAND-WATER

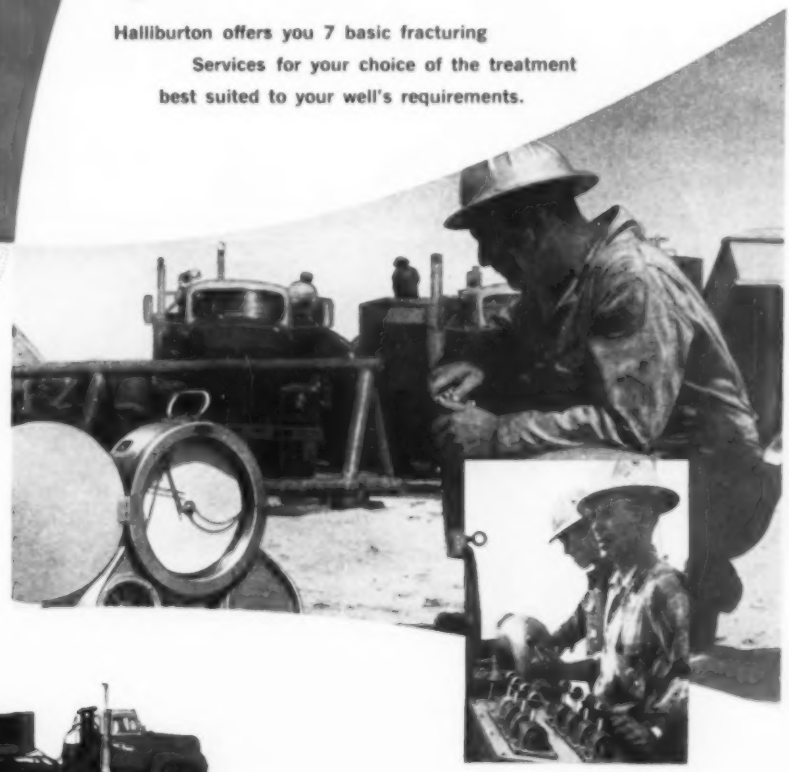
HYDRAFRAC

ACIDFRAC

WATERFRAC

EMULSIFRAC

Halliburton offers you 7 basic fracturing Services for your choice of the treatment best suited to your well's requirements.



SANDOIL—Refined or crude oil. Economical for big or small volume fracturing jobs.

VIS-O-FRAC—Low cost, low friction-loss thickened fracturing fluid prepared from your own crude.

SAND-WATER—Inexpensive for use on water, gas and oil wells. Can be easily adjusted with selected additives to meet various well conditions.

HYDRAFRAC—Gelled kerosene or diesel oil. Excellent for shallow to medium depth wells with low bottom hole pressures.

ACIDFRAC—An acidizing-fracturing combination treatment. Particularly applicable to formations containing acid soluble compounds.

WATERFRAC—Gelled fresh water, salt water or oil field brine for fracturing water, gas or oil wells.

EMULSIFRAC—Stable to high temperatures. Exceptional sand-carrying ability. Controlled emulsion, economically prepared from your own crude.

4 VARIATIONS OF BASIC FRACTURING SERVICES:

PERFPAC—Method for temporarily sealing individual perforations with balls . . . establishing flow through other perforations to create additional fractures.

MULTIFRAC—A technique for producing multiple fractures. Applicable through perforated casing or in open hole.

BIG FRAC—Large volume, high injection rate treatments for increased fracturing efficiency.

VERTIFRAC—Procedure for creating vertical fractures in open hole.

Call your local office or write the Halliburton Oil Well Cementing Company, Duncan, Oklahoma.

Ask for your free copy of Bulletin: "Elements of Hydraulic Fracturing".

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OIL WELL CEMENTING COMPANY, DUNCAN, OKLAHOMA

PIONEERS IN FRACTURING SERVICES

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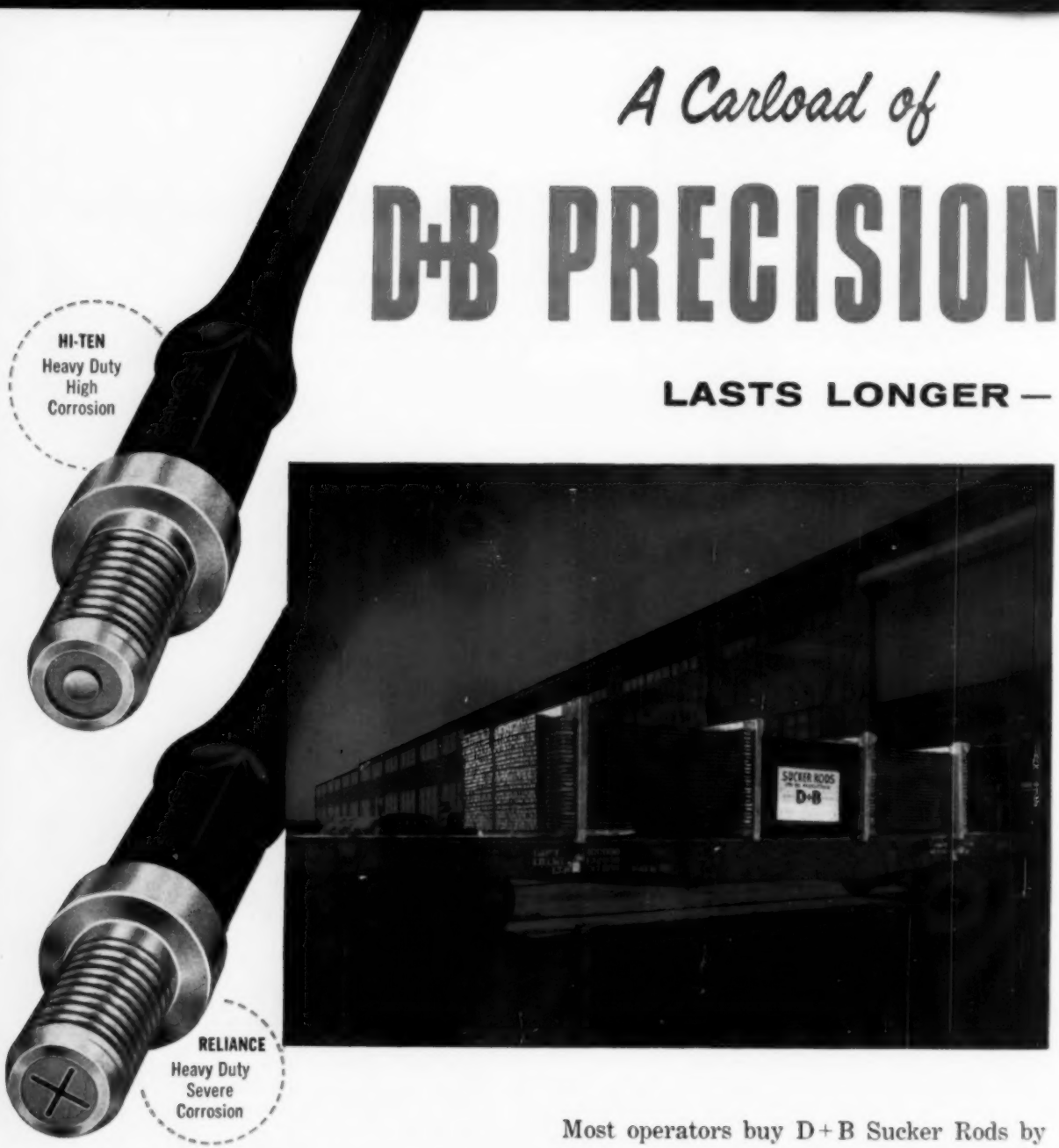
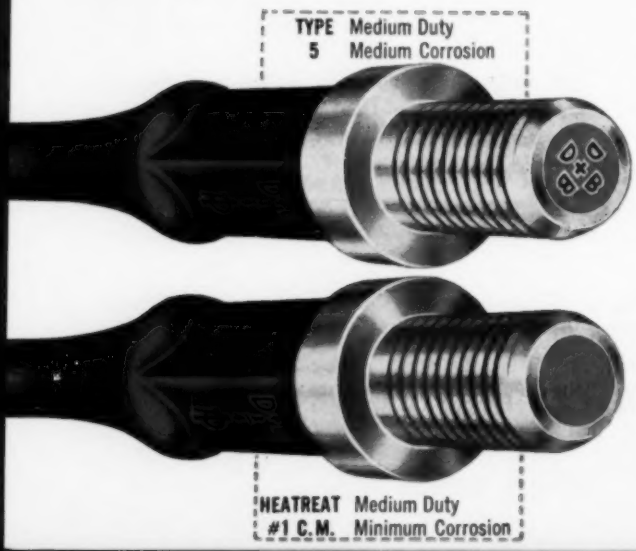
A Carload of

D+B PRECISION

LASTS LONGER—



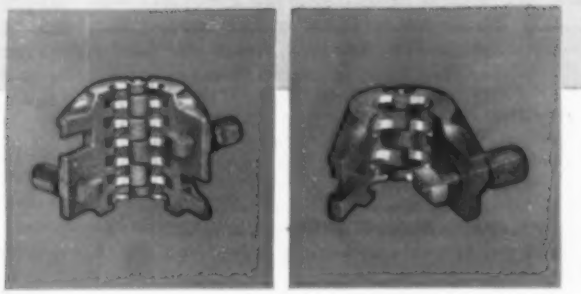


Most operators buy D+B Sucker Rods by the carload—some buy many cars—because they have more hours of actual pumping life, save the operator time and money, and cut down-time to a minimum.

Precision manufacturing, the best scientifically controlled materials, careful inspection and shipping, and 50 years of experience, stand back of every D+B Sucker Rod. Is it any wonder they stay in the hole longer?

-BUILT SUCKER RODS

RESISTS CORROSION — CUTS DOWN-TIME!



D+B KWIK-GRIP® ROD CLAMPS
—FOR ONE-MAN INSTALLATION

Eliminates "knuckle busting." Easy quick opening is provided by a quarter turn of Tee-head permitting special forged bolt to slide through slot to remove clamp. Meets API specifications for pulling load.

D+B DUAL-PAC® STUFFING BOX
—A MAJOR TIME SAVER

Use of dual packing permits replacing the pressure seal packing easily without killing the well. Due to superior design, the higher the well pressure, the tighter the seal. Exceptionally wear resistant.

Get all the facts today about D+B Sucker Rods—the life line of the oil pumping business. Call or see your nearby Continental-Emsco store.

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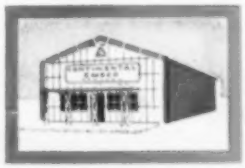

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SR-701

For Dual String Completions – Flowing or Pumping

Use GUIBERSON'S RETRIEVABLE TYPE RD PACKER

Type RD Packer with Anchor and Plain Stinger

This cleanly designed, rugged packer is an outstanding Guiberson development for dual string installations in wells of any depth.

Outstanding in performance because it operates perfectly with both zones flowing, high or low differential pressure; with either zone flowing, the other zone pumping; with both zones pumping; with either or both zones on gas lift; or for multi-zone injection — gas or water.

Outstanding in advantages because it completely isolates each zone from the other and from the casing; provides full opening long string to lower zone; permits either string to be pulled or run separately.

Guiberson's RD packer does complex dual zone jobs so well that operators tell us it's their best investment for dual string production. Ask your Guiberson representative about installation and auxiliary equipment recommendations.

Guiberson's RD packer has smooth operating dovetail slips of heat-treated alloy steel. Packing rubber is one-piece sleeve type — will not vulcanize in the well, made of Guiberson's special oil and gas resistant compound. You can get the RD packer with or without anchor, and a choice of stingers, plain or with jay-hook. Piston slips have extra large gripping area, are heat-treated alloy steel and keyed to anchor body to maintain proper alignment. Get the Best — Get Guiberson.

THE GUIBERSON CORPORATION

ESTABLISHED 1919
DALLAS, TEXAS
U. S. A.

Sold by Oil Field Supply Stores Everywhere

Stories Give Distorted View Of Oil Business

How often have you heard someone say things like . . .

"Texas oil men have a special line of cars this year — disposable gold Cadillacs . . ."

"What chance has a small producer got? The big oil companies swallow him up. . . ."

"Oil — *that's* the business to be in! Just dig a hole in the ground and pump up the money!"

Sure, *you* know better. But that's what a lot of people are saying — and thinking — about the producing end of the oil industry. It's a distorted picture of what is probably the most publicized and least understood phase of the industry.

Ideas like this hurt the oil industry. They hurt *you*.

When people come to you with typical "oil man" stories, what do you say? It's not enough to say they're wrong. You've got to back it up.

Texas oil millionaires? Sure, there are some. If there weren't, oil men wouldn't stake their courage and cash on the 43-to-1 chance of finding oil in paying quantities in a wildcat well. For every Texas oil millionaire, there are hundreds of oil men who have sunk more money in the search for oil than they ever got back. But nobody is going to hear about them — except from you.

No room for the "little guy" in oil production? Take a look at these figures. More than three-fourths of all our new oil is found by the smaller independent operators — ranging from men who literally "work out of their hats," to small-size companies. And although there are more than 12,000 oil producing companies in the United States, only about 34 of these are so-called industry "majors."

Dig a hole in the ground and pump up the money? More likely, start drilling and keep pumping money *in*. Wildcat wells cost anywhere from $100,000 to more than a million dollars to drill. Nobody will give you a written guarantee that oil will be there, or that there will be enough to pay off — or even enough to bother pumping out of the ground at all. Only one wildcat well in 44 produces in paying quantities, and only one out of almost a thousand produces enough to keep America supplied for six days.

There's another story you're likely to hear. It has a lot of variations, but it runs something like this:

"Oil is a natural resource — it belongs to all of us. Seems to me the government should take a hand in the business to make sure it's run right."

Some countries *do* run their oil business that way. But . . .

U. S. oil men have drilled more than 100 times more wells per square mile on America's potential oil land than has the rest of the world on its potential oil land. World-wide they have discovered two-thirds of all oil found to date, and produced about 60 percent of the world's oil.

That's freedom and competition's record. We need to do all we can "to make clear how well the people of the United States are served by America's oil businesses and to gain support for conditions under which they can continue to be privately managed, fully competitive and financially sound."

Know oil's story — be proud of it — tell it. You are the best one to get it across straight. Your answers carry weight, because you're an oil man. And to the public, you are the *industry*!

LARGE or LITTLE

— inshore and offshore

The Whitney offers facilities for financing exploration, crude oil production, refining and marketing of oil and gas resources.

WHITNEY NATIONAL BANK OF NEW ORLEANS

Established 1883

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

U. S. Coast Guard Licenses for Small Boat Operators

A program to obtain United States Coast Guard licenses for Shell Oil Company employees who operate small boats in Louisiana's inland and offshore waters as a part of their daily jobs is now underway. A similar program was conducted by the company several years ago.

Although the law does not require licenses for operators who do not carry persons or freight for hire, the company feels that all employees who operate boats should voluntarily pass the required examination in the interest of safety.

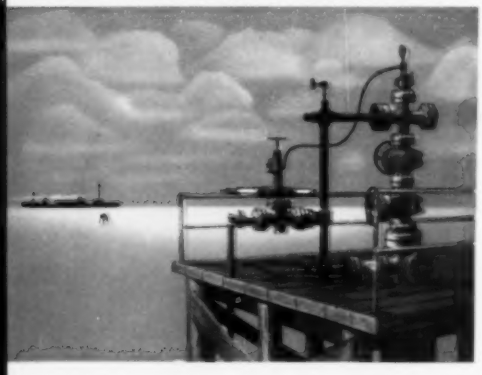
Under the direction of the company's New Orleans training department, employees are given a manual to study and attend a lecture session before being examined orally by a Coast Guard representative. Prior to the examination, each man is required to take a physical examination and a Stillings test for color blindness.

More than 20 lecture and examination sessions will be given at various locations in the company's operations in South Louisiana.

The program covers routine safety precautions on small boats such as proper fueling procedures, proper number of life jackets, types of fire extinguishers and their use, proper venting and cleaning of bilges, artificial respiration techniques, and first aid.

In addition, the men study "the rules of the road" or methods for meeting, passing and crossing vessels underway in the inland waters of the United States. They are also taught what to do in a fog, when proceeding down a narrow channel, and when approaching an obstructed bend.

Rules of the road are studied by Shell men as a part of the Coast Guard training. This lecture session is one of 20 given at the company's various locations in South Louisiana.



OTIS
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Night-and-Day Protection
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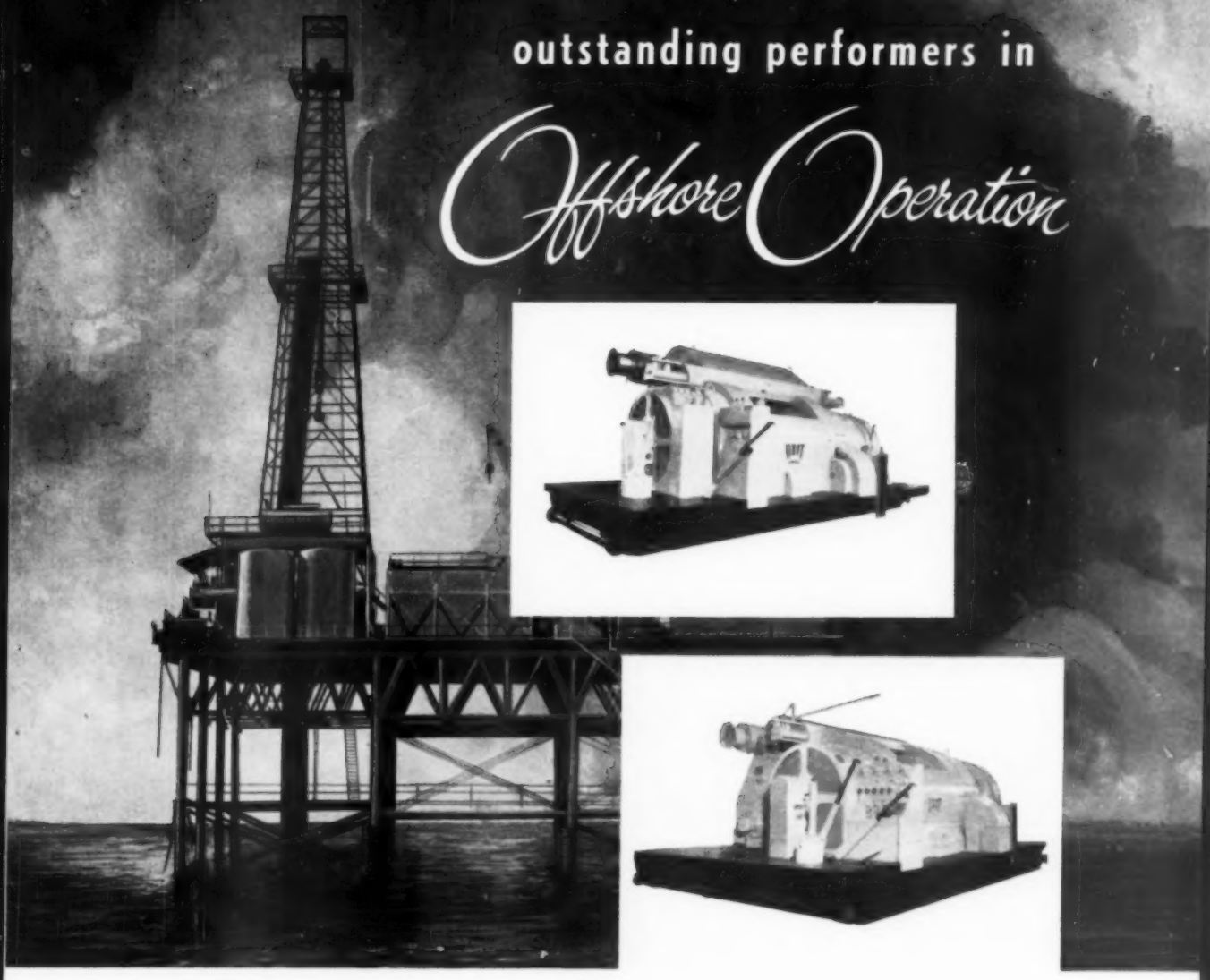
OTIS/Branches Throughout the Oil Country



UNIT RIG'S U-914-B and U-1220

These two UNIT RIG draw works have established outstanding performance records in offshore operation. Dependable performance, simplicity of operation, and ease of maintenance are design characteristics of the units. Other features are extra large diameter and wide spooling drum — large braking capacity — centralized lubrication — corrosion protection on all bolts and pins, and many other outstanding features essential for offshore operation.

The U-914-B and U-1220 draw works are both available for electric motor drives.

See your nearest UNIT RIG representative or write UNIT RIG in Tulsa for complete specifications.

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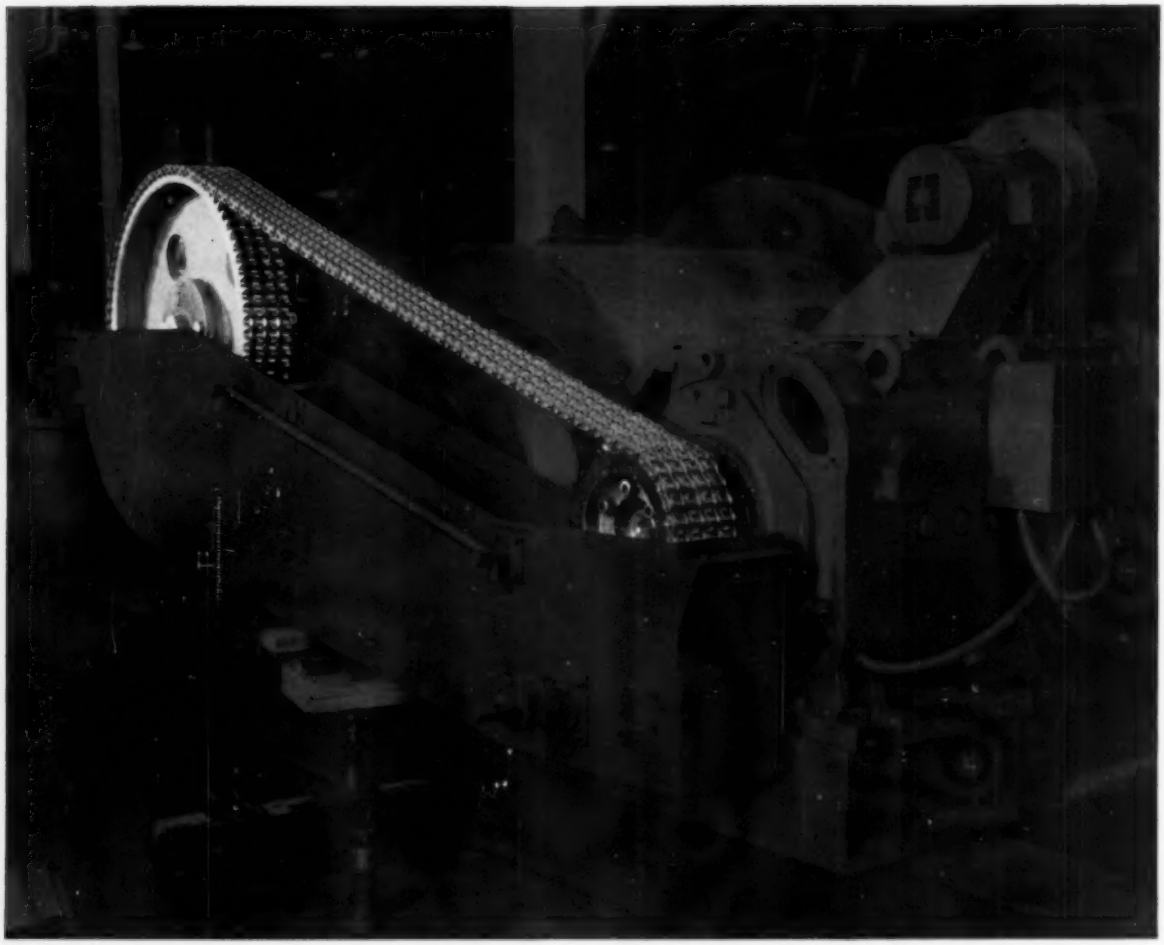
CABLE — MIDUNITRIG

Citations Made at Pacific Coast API Meeting



In offshore oil-well drilling, there's no time for "downtime." So all three pumping units assembled by Stewart & Stevenson for Glasscock Drilling Company's new 7500-h.p. mobile drilling unit, Mr. Gus. Number Two, use Morse High-Endurance Roller Chain!

WHY MORSE HIGH-ENDURANCE ROLLER CHAIN LASTS UP TO 4 TIMES AS LONG AS ORDINARY CHAIN

Morse High-Endurance Roller Chain is designed and built for longer drive life. Fatigue life ranges up to 400% greater than conventional chain under the same load conditions!

The reason, of course, is improved design and manufacture. Rollers are treated for highest impact resistance. Side-plate design eliminates localized stress areas. All H-E side plates are heat treated under exacting controls for durability, and pre-stressed by shot-peening for longer, trouble-free life.

Morse H-E Roller Chain operates on standard roller chain sprockets. Gives you low operating cost, and minimum maintenance costs.

High-Endurance Chain is available through your local supply stores from conveniently located Morse warehouses at Houston and Odessa, Texas.

In other areas, call your Morse man listed under Power Transmission in the Yellow Pages of your phone book. *MORSE CHAIN COMPANY, ITHACA, NEW YORK. Export Sales: Borg-Warner International, Chicago 3, Illinois.*

IN POWER TRANSMISSION
THE TOUGH JOBS COME TO

MORSE MORSE BW *Trademark

Citations Made at Pacific Coast API Meeting

CITATIONS for outstanding services were awarded to six men at the Annual Banquet of the Pacific Coast District, American Petroleum Institute Division of Production, at the Biltmore Hotel in Los Angeles May 16.

The citations were presented by D. L. Connelly, vice president of Warren Petroleum Corporation, Houston, Texas, in his capacity as API vice president for production.

Those honored were: Dr. M. L. Barlow of the California State Department of Education for his long and outstanding service in the training of industry personnel, as special advisor to Pacific Coast District committees.

The late Ray Zell (posthumous) of Union Oil Company of California, for his long and meritorious service to the API standardization program.

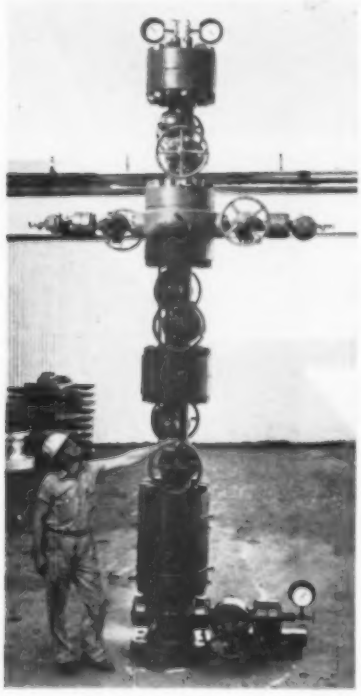
J. K. Kellogg of K. L. Kellogg and Sons, for his commendable service as chairman of Drilling and Production Practice committees.

F. T. Lloyd of Richfield Oil Corporation, for his exceptionally skillful service as chairman of the Production Sessions Program Committee in 1954-55, general chairman in 1955-56, and Pacific Coast district chairman, '56-57.

E. A. Plunkett of The National Supply Company for his outstanding service in the General Arrangements Committee.

Charles T. Reichert of The National Supply Company for continuous outstanding service since 1949 as treasurer of the Pacific Coast District.

To tame a wildcat — this giant dual completion Christmas tree, with a height of 18 ft excluding its casing heads that was tested for 15,000 psi pressure, has been installed on a discovery well in the Gulf of Mexico offshore from Cameron Parish, Louisiana. Natural Gas and Oil Company, a division of Mississippi River Fuel Corporation, and Ocean Drilling



and Exploration Company, announced the dual completion of the well, the State Lease 1172 No. 1, as a gas-distillate wildcat producer. Drilled in the East Cameron area, the well unofficially tested 3,300,000 cu ft of gas and 41 bbl of 44.6 deg condensate on a 10/64-in. choke daily in the lower zone, perforated between 13,056-13,120 ft. Upper zone flow, perforated between 12,902-20 ft, tested 3,100,000 cu ft of gas and 36 bbl of 46.3 deg condensate daily.

Well was drilled by Ocean Drilling and Exploration with Natural Gas and Oil Company serving as operator under a farmout agreement with the Magnolia Petroleum Company. The tree was manufactured by Oil Center Tool Company.

Exclusively
SPANG
The ONLY...and we do
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weldless alloy-steel
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One piece — no welds to break.
Drills up to four times more footage with less time and costs spent on fishing jobs!
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For over 60 years Manufacturers of Spang Weldless Jars and a Complete Line of Cable System Drilling and Fishing Tools for Oil and Gas Wells, Prospect Drilling and Shot Blast Holes.

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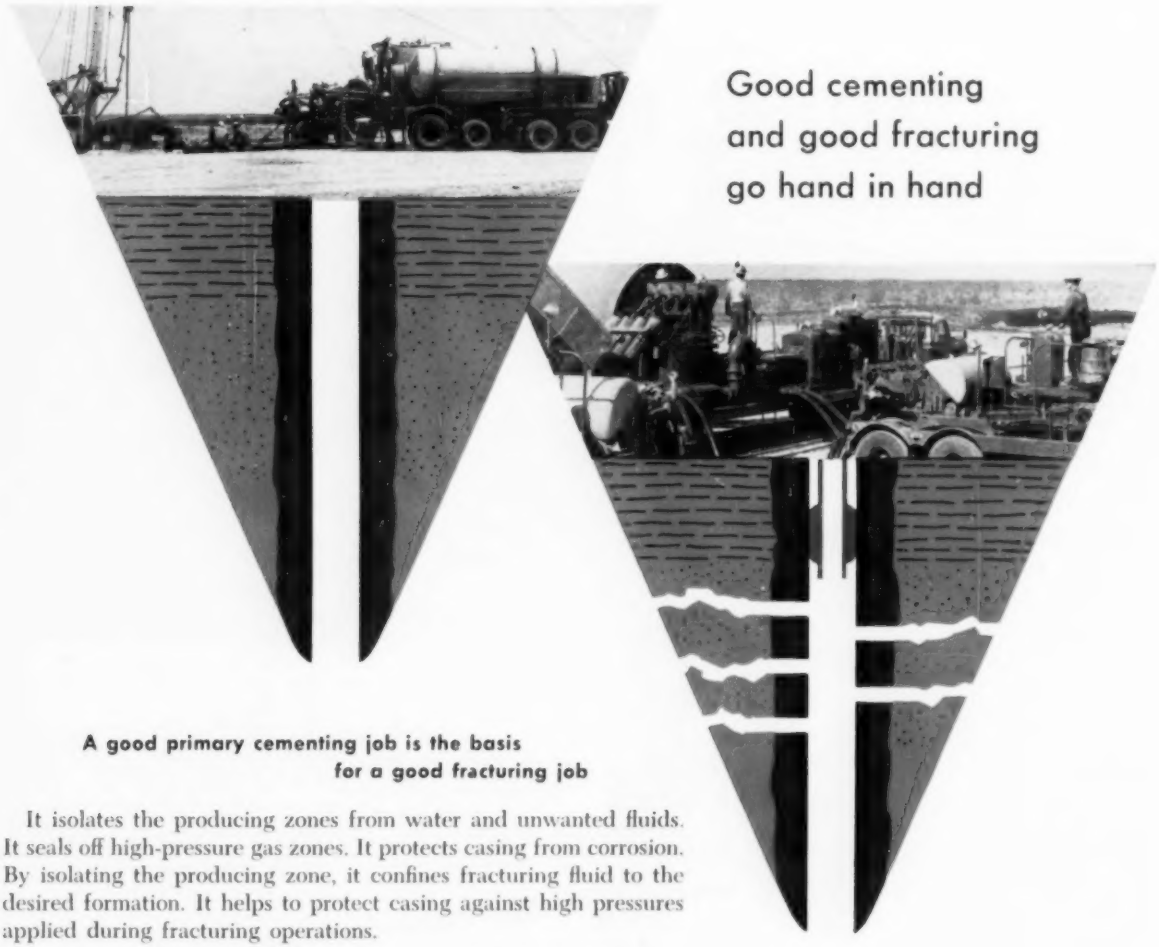
HERE'S HOW HALLIBURTON
CEMENTING SERVICES

pave the way to better fracturing



Good cementing
and good fracturing
go hand in hand

A good primary cementing job is the basis for a good fracturing job

It isolates the producing zones from water and unwanted fluids. It seals off high-pressure gas zones. It protects casing from corrosion. By isolating the producing zone, it confines fracturing fluid to the desired formation. It helps to protect casing against high pressures applied during fracturing operations.

A Halliburton cementing job gives greater assurance that your well will get the effective cementing it needs to prepare it for effective fracturing. And for protection of oil throughout its lifetime of production.

The time to start thinking about fracturing is before the primary cementing job. And the company to call for cementing is Halliburton.

"A WELL THAT'S WORTH CEMENTING...IS WORTH CEMENTING WELL!"

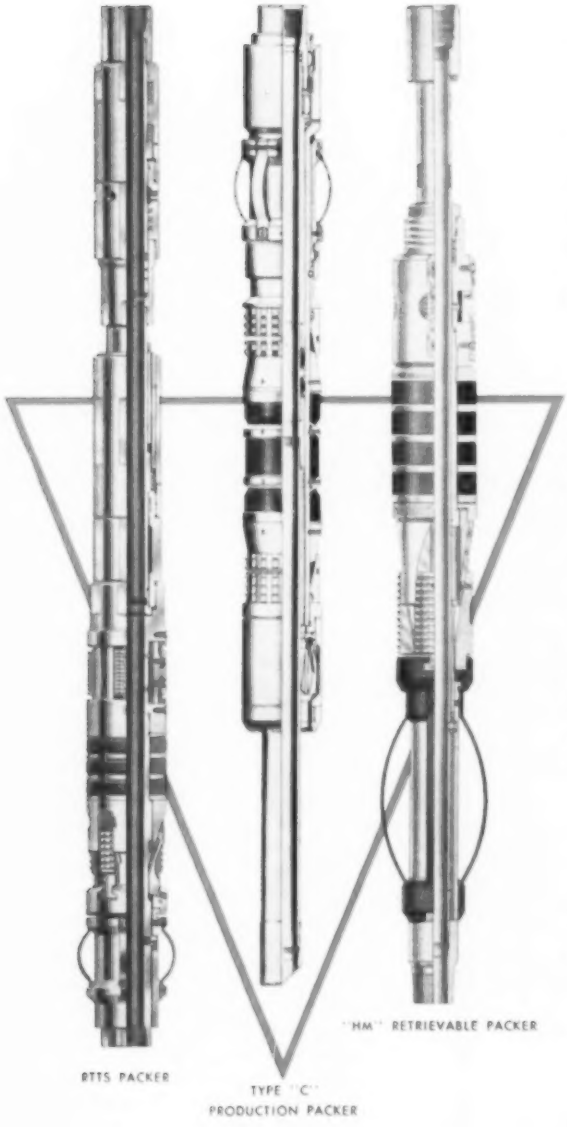
HALLIBURTON

OIL WELL CEMENTING COMPANY

DUNCAN, OKLAHOMA

HALLIBURTON PACKERS . . .

Utility-designed for better fracturing



HALLIBURTON RTTS PACKER (Retrievable-Test-Treat-Squeeze Packer)... multi-purpose hook wall type retrievable packer with a full-opening mandrel, designed for use in fracturing, as well as testing, chemical treating, and squeezing operations.

Hydraulic hold down with large slips built into the tool above the packer rubbers. Slips engage the casing only when pressure is applied through the tubing to the area below the packer to prevent any upward movement of the packer due to force created by the pressure under the packer. Full-opening mandrel permits the pumping of large volumes of fluid with minimum pressure drop, also allows passage of tubing-type perforating gun. Operated by simple tubing manipulation.

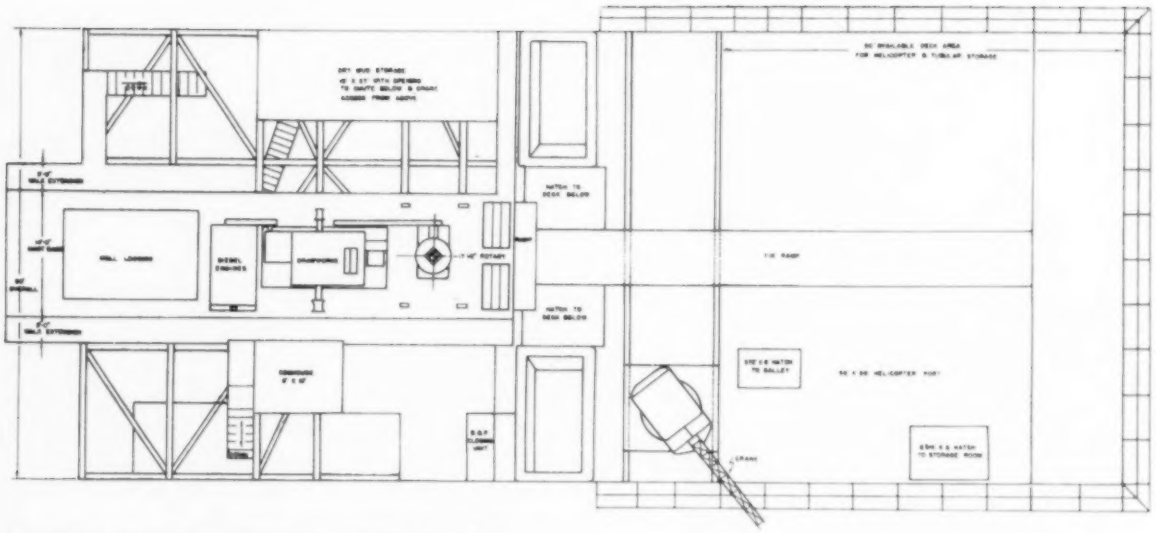
HALLIBURTON TYPE "C" PRODUCTION PACKER with Latch-on Sealing Unit... full-opening permanent-type drillable casing packer run in on tubing and set in the casing above the oil or gas formation to serve as a production casing packer for single- or dual-zone well completions.

Full-opening diameter makes it highly adaptable for fracturing work. After fracturing through packer, well can be swabbed in and put on production, requiring no round trip with tubing. Latch-on Sealing Unit provides tight fluid or gas seal between packer and tubing string, reduces or eliminates necessity for setting tubing weight on packer.

HALLIBURTON HM (Hydro-Mechanical) RETRIEVABLE PACKER... full-opening hook wall type packer designed to be run in cased hole on tubing to isolate a section to be fractured, acidized or tested.

Hydraulic slips engage casing only when pressure is applied through tubing to area below packer. These slips prevent the packer being moved up the hole by high injection pressure applied below the packer. Full-opening mandrel permits pumping a high volume of fluid with minimum pressure drop. May be set as many times as desired without coming out of hole.

CEMENTING SERVICES · FRACTURING SERVICES



Is this the answer to economic, offshore well-servicing?

skid mounted

A practical piece of equipment incorporating new ideas in design — fully portable — capable of performing workovers to 15,000 ft and drilling to 6,000 ft — fully equipped and self-contained.

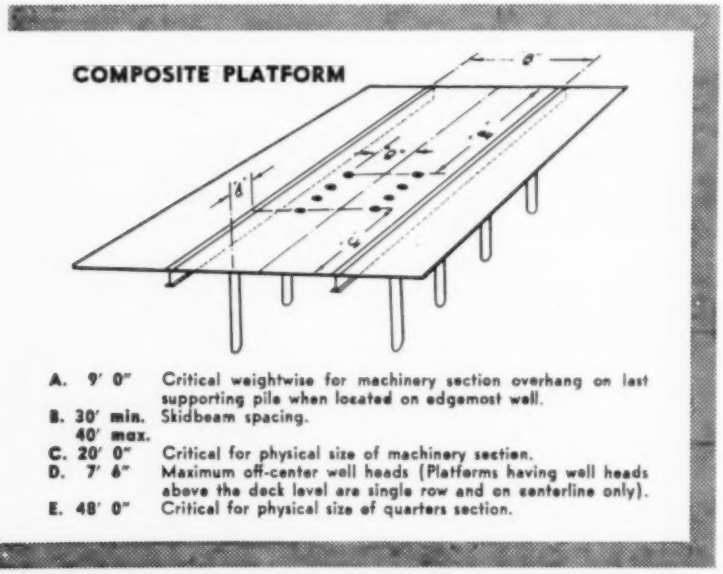

COMPOSITE PLATFORM
A. 9' 0" Critical weightwise for machinery section overhang on last supporting pile when located on edgemost well.
B. 30' min. 40' max. Skidbeam spacing.
C. 20' 0" Critical for physical size of machinery section.
D. 7' 6" Maximum off-center well heads (Platforms having well heads above the deck level are single row and on centerline only).
E. 48' 0" Critical for physical size of quarters section.

FIG. 3. **Composite platform** is based on designs used by the various companies operating in the Gulf. The workover rig may be placed on all standardized production type platforms. Servicing operations can be performed on any of the wells of multiple well platforms having from 30 to 45 ft span skidbeams. To locate the rig on off-centered wells (two-row platforms), mast and rig on a common base are skidded sideways atop the main machinery structure with two 38-ton hydraulic jacks.

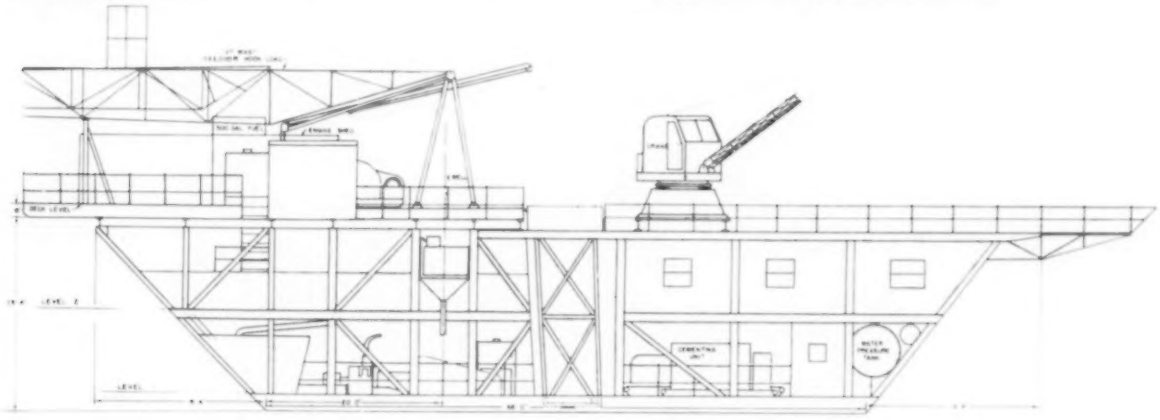
A completely integrated, skid mounted, workover rig has been designed to provide an answer to the economic problem of servicing offshore wells on production-type platforms. It is believed that this objective can be met by providing a universal non-mobile servicing unit, completely self-contained, which can operate at a savings if the job requires as long as 7½ days on location. The unit is self-contained in that it is completely equipped with drilling and auxiliary equipment, storage facilities, auxiliary maintenance and service equipment, crews quarters, and transportation and supply handling facilities; all conveniently arranged on rigid supporting structures.

Unless costs involved in drilling and servicing offshore wells are materially reduced from present day figures, many fields which will be found in the tidewater area will be classified as uneconomical production; fields which onshore would be drilled to capacity. The fact that the offshore production will be accompanied by servicing problems is borne out by offshore wells currently in production, and by records of adjacent onshore wells producing from the same sands as those offshore.

The practice of using the large platform-type drilling rigs with drilling tenders, built for 20,000 ft plus drilling

←— FIG. 1. **Side elevation** of the workover rig illustrates compact construction of the complete unit. Equipment is so arranged that if a 250-ton capacity barge crane is used for transportation, only two lifts would be involved in unloading. In planning the unit, a minimum workover time of eight days was used to base equipment and supply space needs.

FIG. 2. **Top elevation** of the integrated unit shows the vertical pipe bins — and its overall completeness. While non-mobile, it can be transported and lifted in two or four loads. Included in the unit are all drilling and auxiliary equipment, storage facilities, auxiliary maintenance and service equipment, crews quarters, and transportation and supply handling facilities.



R. J. Silberman
Equipment Design Engineer
Ashby Drilling Company, Dallas, Texas

OFFSHORE WORKOVER RIG

at costs from $4000 up per day is definitely an uneconomical servicing procedure when considering the type of equipment that is actually required for servicing. Economical servicing is being performed in inland protected waters with a standard servicing unit and essential equipment is barge-mounted but without crew's quarters or a large amount of storage space. Crews and supplies are transported by boat to the unit with comparative safety, regularity and low cost.

However, the transportation problem changes as distances from the shoreline increases. Costs of supply boats, crew boats, barges, barge cranes, etc., are figured to include time enroute to and from as well as time at the location. Weather also becomes an increasingly important factor. This small unit, dependent upon transportation facilities, becomes uneconomical and impractical as a piece of offshore equipment.

In what is considered the offshore areas, two basic types of production platforms are encountered:

Type 1: Single or double well, four-piling type protective platforms.

Type 2: Multiple well (6 to 14 wells) piling-type production platforms.

A self-contained unit to service the Type 1 platform would have to be mobile itself or be continuously tended by a mobile piece of equipment because load limitations of the small platform do not permit setting heavy equipment on it. If on a mobile self-contained servicing unit, the unit itself can be transferred or physically moved on to the Type 2 platform and yet be tended by the mobile unit, the result is a so-called universal mobile piece of equipment. But, in using a universal mobile piece of equipment on the Type 2 platform, the producer is again confronted with the all-important consideration of paying a day rate on an expensive piece of transporting equipment being used unnecessarily or as standby only. This becomes uneconomical when the idle period at the day rate for the idle equipment exceeds the cost of transporting the servicing unit to the location by barge crane (see Table 1 for calculated break-even

TABLE 1. Approximate Comparison of Tender-Platform, Mobile Self-Contained, and Non-Mobile Self-Contained Type Servicing Unit Costs at the Break-Even Period.

	TENDER-PLATFORM UNIT			MOBILE SELF-CONTAINED UNIT			NON-MOBILE SELF-CONTAINED UNIT		
	Days	Rate/ Day	Cost	Days	Rate/ Day	Cost	Days	Rate/ Day	Cost
Barge crane rental (Location to location)	2½	†10,000	25,000	1	*1200	1200	1½	†10,000	15,000
Equipment rental during moving period		3600	9000		4000	4000		2000	3000
Equipment rental during contract time	6	4000	24,000	6	4400	26,400	6	2200	13,200
Total cost of well requiring approximately 7½ days total elapsed time			58,000 (8½ days)			31,600 (7 days)			31,200 (7½ days)

*Includes two tugs @ $600.00 per day.
†250-ton crane. A savings could be effected using a 125-ton crane with either the tender-platform or non-mobile self-contained units.

Shooting Tests

From the test results shown here, it is evident that the 2⅛" Capsule-Jet can be utilized in all types of well completions requiring a shaped charge perforator.

Penetrations, as shown and described in both the target and the illustration, were obtained in cured neat cement.

CAPSULE-JET PERFORATIONS HAVE A HIGH FLOW RATE

The introduction of the expendable perforator by Schlumberger in 1951 opened an entirely new field of well completion practices. From the research and engineering laboratories of Schlumberger, now comes the latest and best in shaped-charge perforators . . . the New Capsule-Jet.

The Capsule-Jet is a thru-tubing expendable perforator in two sizes, 2⅛" and 1-11/16". The design features four or five shots per foot, phased at 90°.

This gun gives greater penetration than any thru-tubing perforator on the market and equals that achieved with the larger 4-inch carriers. The Capsule-Jet is designed to give its maximum formation penetration irrespective of the gun's position in casings up to 7½". This feature is important since the gun generally fires while lying on one side of the pipe.

The Capsule-Jet Perforator gives large, uniform holes to maximum penetration . . . holes that are even larger than the casing holes. The very shape of this perforation practically eliminates plugging—with either remnants of the charge or pulverized sand.

The new Capsule-Jet—with its deep penetration, large casing hole and large uniform formation hole—makes a perforation with superior flow characteristics, proved beyond any doubt in Schlumberger's high-pressure, temperature and flow laboratories.

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Designed to give maximum formation penetration regardless of gun's position in the pipe.

Breaks up into small pieces, and will not obstruct further runs.

It leaves a minimum of debris—The debris from one foot of gun will fill only *one inch* of 5½" casing.

It is extremely flexible . . . allows easy handling of long sections of guns . . . will pass through kinks in the tubing.

It can be assembled with blank spacers to facilitate spacing of shots.

100 feet or 400 shots can be run on one trip in the well.

It can be run in pressures up to 12,500 p.s.i. and temperatures of 325°F.

It leaves no slug or debris in the perforation.

MINIMUM OF DEBRIS

The Capsule-Jet leaves a minimum of debris — just one-half the amount of the tubular guns. The capsule charge cases are made of a special die cast aluminum alloy developed by Schlumberger. The high strength and extremely low ductility of this alloy result in a case which withstands high pressures and has excellent break-up characteristics. The debris from this gun may be dissolved with the same ease as regular aluminum alloys.

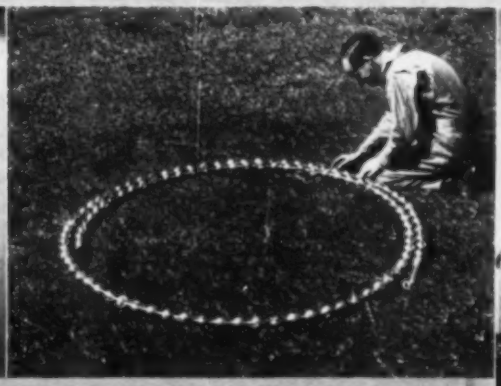
MAXIMUM FLEXIBILITY

The Capsule-Jet is designed with a minimum flexing radius of three feet. This flexibility allows the tool to be run through crooked or cork-screwed tubing without difficulties. Even though this tool is designed for maximum flexibility, charge case linkages are built for strength and durability. They will withstand a pull of 1000 lbs. without shearing.

LENGTHS UP TO 100 FEET

The Capsule-Jet gun can be run in lengths up to 100 feet. The flexibility of this gun will allow long sections to be fed into the riser assembly without the necessity of having to install a high mast or derrick on the well.

The debris from a 13-foot gun (52 charges) recovered from a well in Lea County, New Mexico. Two charges are shown for comparison.



Gun curved into a 3' flexing radius.

Capsule-Jet being fed into riser from the working platform of a portable derrick.

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period). Therefore, a unit which did not tie down an expensive mobile piece of equipment would be the most economical unless extremely frequent moves are made.

Reason for new rig. The purposes of this new type well servicing unit, designed with the facts mentioned above in mind, are to provide a servicing unit which: (a) Can operate on any of the existing multiple well, permanent (Type 2) production platforms; (b) can perform the desired services with a minimum requirement of outside services or outside dependency, and, (c) while operating under the current practices in offshore areas, will cost the producer least for servicing the multiple well (Type 2) platforms.

Basic Rig Design

The servicing unit is completely self-contained except for means of transportation of the unit itself to and from the platform. If a 250-ton capacity barge crane is used for transportation, there would be only two lifts involved when unloading. The unit is designed so that it may be used on all the standardized production type platforms. After considerable investigation of designs by the various companies operating in the Gulf, a "composite" platform with limiting or critical dimensions was set up as a basis for design (Fig. 3). Some of the more important factors to be considered with regard to the composite platform are:

1. Overhang (physical and weightwise) of the machinery section beyond the last supporting pile when the unit is on the edgemost well.
2. Distribution of loads to the spans of the various platform's skid beams.
3. Movement of hoisting equipment, rotary equipment and mast over all the possible well locations.
4. Clearance of the structure beyond the above-the-platform well heads.
5. Overhang of the quarters section in pinned position for every well location.

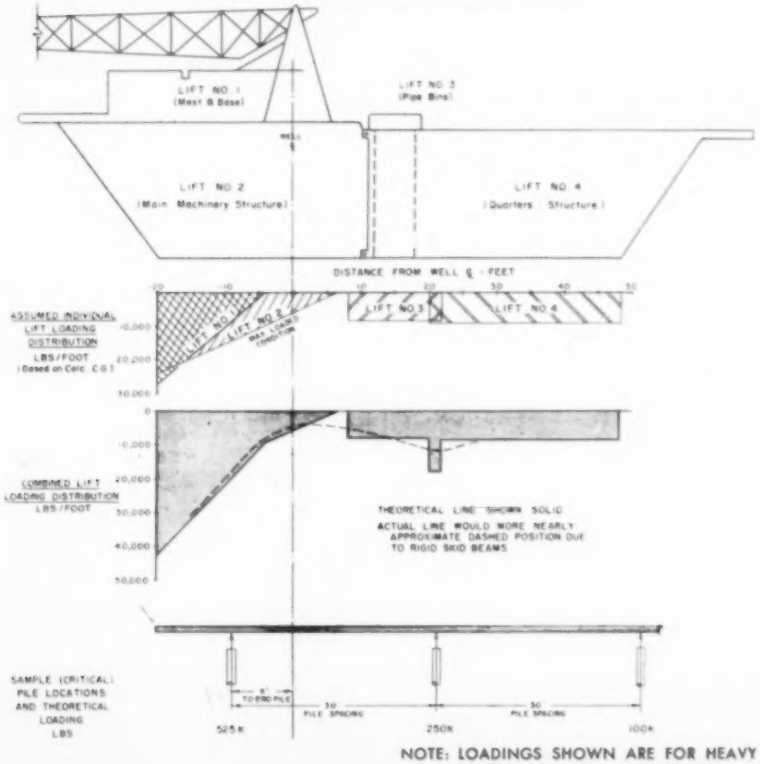
Structure features. The resulting unit is approximately 120 ft overall length (68 ft at the base) when sections are pinned together. Overall width is 50 ft and maximum height is 30 ft with the mast in horizontal position. Servicing operations can be performed on any of the wells of the multiple well platforms having from 30 to 45-ft span skidbeams. The move from well to well along the skidbeams is accomplished by skidding the entire unit with two 120-ton hydraulic jacks.

To locate the rig on the off-centered wells (2-row platforms), the mast and rig on a common base are skidded sideways atop the main machinery structure with two 38-ton hydraulic jacks. When the unit is situated with the heavier machinery on the edgemost well (critical to the platform structure) on what is believed to be the most likely critical-to-loading platform constructed, imposed loadings with maximum fluids are within pile capacities. Neither the main machinery structure nor the quarters section extends beyond the platform limits when the unit is positioned on any of the wells on any of the platforms. (This holds true with but one exception which necessitates setting the quarters section to the side of the main machinery section.) There is a 20-ft wide, 12-ft high slot down the center of the structure providing clearance to any above-the-platform well heads when lowering the unit into position. This slot also insures natural ventilation of a hazardous area about the wellhead during servicing operations.

Drilling specifications. Basically the unit is rated as a 15,000 ft servicing unit, for picking up 15,000 ft of 2⅞-in. OD drill pipe. The placement of equipment and bulk storage had to be planned with careful consideration given to accessibility, weight concentration and purpose. Drilling machinery is contained in the main machinery substructure and on the mast sub-base, both pieces constituting a 250-ton lift. Two pipe baskets (carrying the vertically stacked drill pipe and tubing) are pinned to the quarters section and helicopter deck and are in total another 250-ton lift. If need be, the pipe baskets may be separated from the quarters and the mast base from the main machinery structure to make 125-ton maximum lifts. Loadings imposed on the structure are illustrated graphically on the sample critical loading chart (Fig. 4).

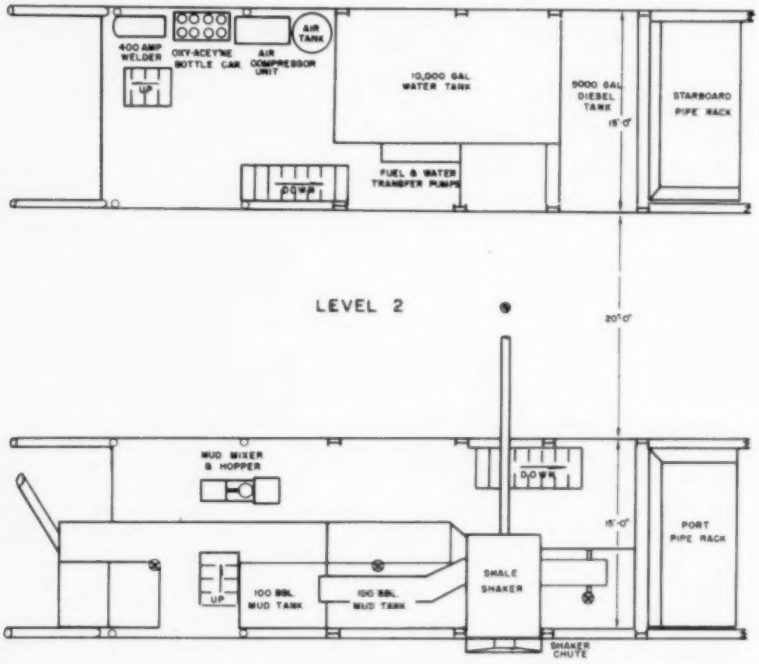
It may be noted from the chart in the section showing pile loadings that the end pile will carry the maximum single load when the unit is located on the edgemost well. This maximum single load could be reduced some 60,000 lb if the mud requirement could be cut to 165 lb (12-lb mud) and the split mud system is used. Values shown in

FIG. 4. **Structure loading and pile locations** are illustrated here in a sample case. Note that in bottom figure, end pile will carry the maximum single load when the unit is located on edgemost well. All values shown in the chart include full fluid and dry mud capacities, 15,000 ft of 2⅞-in. drill pipe, suspended on rotary table and 15,000 ft of 2⅞-in. tubing in pipe bin with mast extended in horizontal position.



NOTE: LOADINGS SHOWN ARE FOR HEAVY (PORT) SIDE ONLY. STARBOARD SIDE LOADINGS WILL BE LESS THAN THOSE SHOWN.

FIG. 5. **Upper level** of the main machinery substructure is actually a bridge consisting of two long box-like structures side by side, with connecting trusses forming the roof of the slot. Note that on starboard side is welding equipment. For welding on the rig floor, leads can be passed up through the structure at several points, without handling heavy welding equipment. On the port, or drillers side, at this level is the mud system. Directly under the shale shaker is the first mud tank. Cuttings from the shaker enter a chute for disposal overboard.



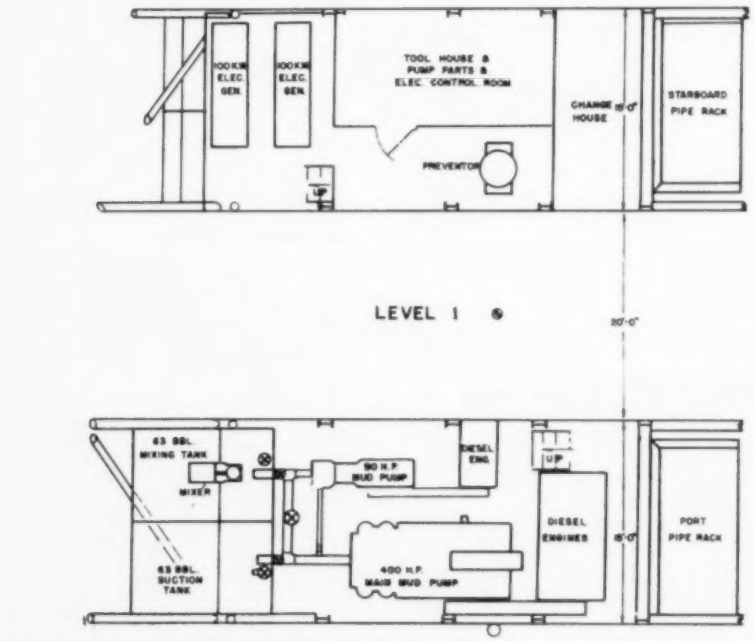


FIG. 6. **Lower level of the main machinery substructure.** On the starboard side, the tool house accommodates parts, tools, electrical controls, and provides a crew change house. Blowout preventer is positioned in a box section while moving the unit from location to location. Rails and hoisting equipment at the rotary position are provided for moving the preventers from the well. Suction tank, at one end on this level of the port side, is below the level of the mud tank; for this reason automatic level control has been planned to guard against over and underflow.

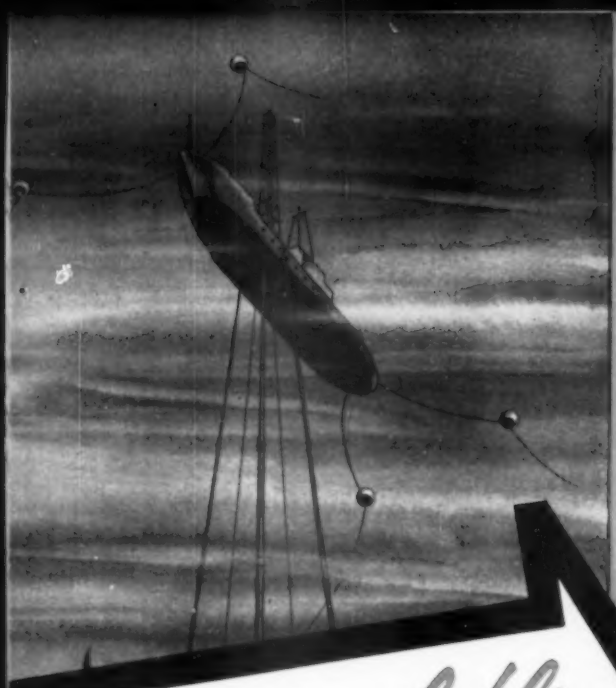
the chart include full fluid and dry mud capacities, 15,000 ft of 2⅞-in. drill pipe suspended on rotary table, 15,000 ft of 2⅞-in. tubing in pipe bin with mast extended in horizontal position. Additional weight which would load any but the end piles would not be critical. The only time that the above condition might occur would be when the tubing is suspended in the rotary and the mast is lowered for emergency hurricane winds. With the mast raised, lift No. 1 center of gravity would move toward the well centerline, and end pile loading would be slightly relieved in this case. Bending of the skidbeam due to overhung loads would be appreciably reduced.

Multi-purpose Mast Base. The 54-ft long by 14-ft wide mast base skids on the main machinery structure carrying with it the mast, drawworks, logging unit, mast headache rest, doghouse, rotary table, and extended walkways. The 127-ft jackknife-type mast is rated at 393,000 lb capacity hook load and is capable of withstanding 100 mph wind loads without guys. Mast is raised from behind the drawworks with the drilling line strung over the A-frame. With 11-ft 10-in. derrick leg spacing, there is ample work area around the rotary table. A minimum of 15,000 ft of 2⅞-in. tubing or 3½-in. drill pipe can be racked in the mast at one time.

The 400-hp drawworks is the double drum type with 15,000 ft of 9/16-in. wire line capacity on the sand reel. Power is supplied through an engine-mounted torque converter from diesel engines behind the drawworks. The main drum is equipped with a hydromatic brake. The 17½-in. rotary table is chain driven from the drawworks.

Mounted within the drawworks body panel is a small hydraulic unit for powering the hydraulic tongs and for connection to the preventer closing unit as an auxiliary power safety feature. Logging unit is located in a convenient position behind the drawworks and does not interfere with the mast in the down position. The 7 ft by 12 ft doghouse contains knowledge box, miscellaneous tools, geolograph, work benches, clothes hangers, and bulletin board. Walkways and stairways to the skidding mast base are arranged so that when the mast base is skidded to get over the maximum off-center well (7½ ft), there will be no interference with other deck-mounted equipment, and walkway sections can simply be shifted from one side of the base to the other.

Main machinery substructure. The main machinery substructure itself is actually a bridge consisting of two relatively long box-like structures side by side with connecting trusses forming the roof of the slot. Trusses are of sufficient strength to transfer drilling



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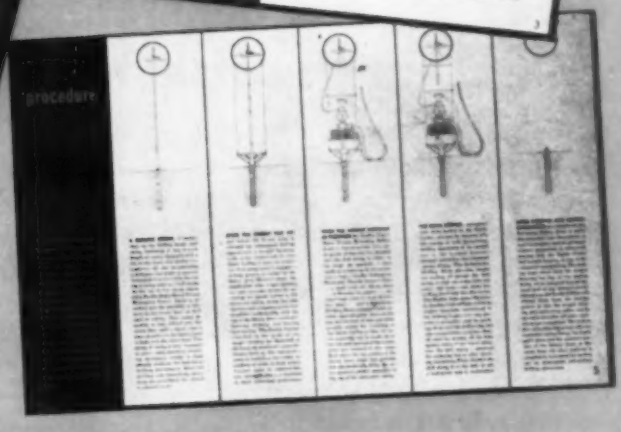

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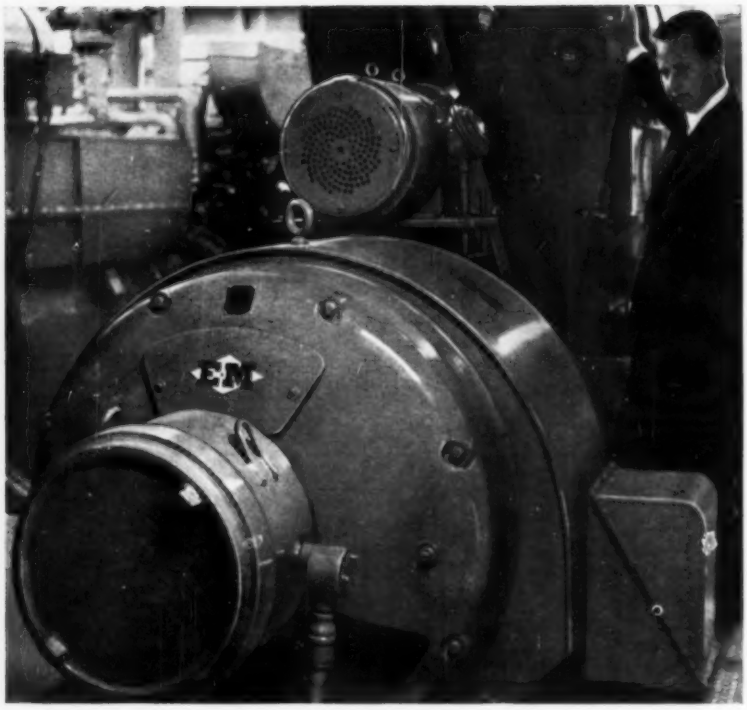

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loads, mast raising loads, and wind loads through to any of the 30 ft, 40 ft or 45 ft span skidbeams that the unit might be situated. In this manner the loads imposed by the unit are not transmitted to the wooden deck, but directly to the platform piles via the skidbeams.

The main machinery structure houses the 5000 gal fuel tank, 10,000 gal drilling water tank, 15 hp electric motor drive compressor unit and 12½ cu ft volume tank, fuel and water transfer pumps, 400 amp arc welding equipment (a-c motor driven), acetylene welding equipment, crew change house, and pump, parts, tool, and electrical control house. Also mounted in the main machinery structure are a pair of 100 kw 3 phase a-c generator units, each direct-connected to a diesel power plant. Each unit is capable of assuming the total load demand in case of emergency, that is without air conditioning, welding and other small non-essential loads.

On the opposite side of the slot, fabricated integrally in the structure are two 100-bbl mud tanks, a 63-bbl mixing tank, and a 63-bbl suction tank. Each tank is piped for gun agitation and jetting mud overboard; the mixing tank is equipped with a 15-hp electric mixer. A 90 hp 5 by 8-in. duplex piston mixing pump, chain driven by a 4 cylinder diesel engine and a 400 hp 7½ by 14-in. duplex piston mud pump chain driven by torque converter diesel engines are also mounted on the drillers side. Atop the main machinery structure is a storage house for approxi-

The Author

R. J. (Buddy) Silberman is equipment design engineer for Ashby Drilling Company of Dallas, Texas. Shortly after he was graduated from Rice Institute with a degree in mechanical engineering in 1949, he joined the Houston plant of the National Supply Company as a product design engineer in the wellhead department. When the company opened its rigging-up activities, he assumed the engineering duties of that department which involved repair, assembly, and design of a great variety of oilfield drilling and production equipment, including the design of Ashby Drilling Company's two highly portable slim-hole rigs.

Since joining the Dallas drilling contractor, he has spent much of his time studying offshore drilling and workover structures and designing an offshore servicing unit. He has also initiated preventative maintenance procedures on the company's equipment and follows the company's drilling operations in the Julesburg Basin.

mately 1000 sacks of mud. Preventer control equipment is also mounted atop the structure accessible to the driller. In the slot and attached to the trusses at the rotary position are rails and hoisting equipment for transferring preventers from the well to a position provided for within one of the box sections on the lower level while moving the unit. A water distillation unit can be accommodated if the contractor elects to eliminate water hauling to the location.

Mud system. Mud tanks are arranged and piped for split circulating systems if necessary. A shaker is mounted on the first mud tank to pass cuttings into a chute for disposal overboard. Screened mud can be directed into either of the 100 bbl mud tanks. A mud lab and a means of access to the shaker for samples is provided near the shaker itself. Since the suction tank is below the level of the mud tank, an automatic level control is necessary to guard against over or underflow. Mud and mixing pump discharges are 100 percent manifolded for maximum flexibility. Manifold valves are mounted in a position near the driller giving him control of distribution of mud to guns and jets, bypass, or rotary hose from the rig floor. The mud pump suctions are cross manifolded for 100 percent flexibility.

For mixing, sack mud is transferred from the mud storage house atop the main structure to the area on the mud tank floor above the mixing tank by means of a steel roller chute. At that point the sack is broken and contents dropped through a hole in the floor onto the mixer in the mixing tank below. Provision is made for storage of approximately 250 sacks at the mud tank level.

For welding on the rig floor, leads can be passed up through the structure at almost any point without handling the heavier welding equipment.

Adequate pipe storage. Vertical pipe bins, each 22 ft high, 13 ft long and 6 ft wide fabricated from 4½ in. drill pipe, are sufficiently strong to enable transferring the pipe from the barge in individual basket loads by the barge crane. During the servicing operations, by handling joints with an air hoist and a soft line over a block on the racking platform, the pipe or tubing can be racked in the bins for keeping the helicopter deck free or to ready the unit for the next move. Actually the bins are tilted slightly towards the crown block to facilitate handling of the joints. Some 12,000 ft of 3½-in. full hole drill pipe or 24,000 ft of 2⅞-in. drill pipe or tubing can be racked in each bin. The helicopter deck could also be used for racking, if desired.

The quarters section is similar struc-

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turally to the main machinery structure; that is, with the two box sections and connecting truss members. Loads again are transferred directly to the platform skidbeams. The entire unit is structurally pinned to the main machinery section through the top and bottom horizontal beams. Built into the helicopter deck is a catwalk for use when racking pipe on the deck.

Loading and unloading. A revolving 25-ton crane is rail mounted onto the helicopter deck for removing barge cargo from either side of the platform. By unpinning the base and winching itself across the deck on the built-in rails, the crane becomes usable on either side. Crane boom can be laid down square across the deck or across the pipe basket to clear the space above the deck for helicopter landings. The usable helicopter deck is 50 by 50 ft and is surrounded by steel wire guard rails. This space is in addition to that which is occupied by the crane or occupied by a production test separator and tank when positioned opposite the crane for testing a well.

For unloading bulk cement and mud onto the deck below for temporary storage, hatches are provided inboard of the pipe baskets. This would put the cement adjacent to the twin cementing units mounted in the lowest level in the port side box of the quarters section. There are other hatches provided in the helicopter deck within boom reach for lowering supplies into the quarters storage room and for handling heavy kitchen equipment for installation in, or subsequent removal from the galley. The deck is also insulated to keep deck noises and effects of extreme temperature from the quarters.

Crew's Living Area

Crew's quarters space were designed for 21 men. Two of the rooms, each with bunks and lockers for five men will serve as the day and night crews' quarters. These two rooms are located on the lower level, near the change house on the starboard side. Occupants of the rooms have access to toilet facilities via the stairway, but are more or less isolated from all other activity or recreational noises during their rest periods.

Above the crew's quarters are four and five-man rooms for visiting company and service personnel and for galley crew, respectively. Nearby are toilet and shower facilities with ample dressing room.

The space above the slot, but below the helicopter deck is fully utilized. At the end of the structure away from the well is a two-man room for the toolpusher and mechanic as well as space for the crew's recreation room. The recreation room provides a connection between the quarters and dining area across the slot and houses TV, reading area, drinking fountain, and card table. A 10,000 gal fresh water tank and 2000 gal potable fresh water tank are mounted within the truss structure between the recreation room and the well end of the quarters structure.

The upper port side of the quarters section houses pantry and storage room, dining area and radio equipment, galley and sink area, stove, freezer, ice-maker, etc. All crew's living area is air conditioned with individual window units, the thought being no complete loss of cooling when an individual unit breaks down or is out for repair. Insulated wooden paneling and studding, wood floor covered with floor tile, attached to a steel outer shell is the general mode of construction.

Below the dining area is a utility room housing washer, dryer, two 80 gal hot water heaters, fresh water and salt water pressure tanks, and 25 hp deep well pump. Coast Guard regulations related to fire, lifesaving and safety, were kept in mind in the design of the unit.

Rig-up Expense

By providing the equipment in a self-contained unit to be handled with a barge crane, the operator has only to pay a daily rate for this equipment plus moving costs. Past records indicate servicing operations in the Gulf extend beyond the so-called eight-day "break even" point for payout on a mobile unit. Besides, on the multiple well platforms, work will occasionally be done on more than one well and no barge equipment is required for a move on the platform. The cost of barge time on any location will be small since only two lifts are required. In the long run the operator will economize with the self-contained, non-mobile, servicing unit.

Another economy can be effected by using a unit of this type to complete wells, allowing the heavier and costlier units to move on to the next location to meet drilling obligations. Going still further, even though the unit has been designed specifically for servicing, the unit is capable of performing efficient drilling to 6000 ft.

It is conceivable that a contractor working with two or more servicing units described above within a given area might operate a single barge crane and utility boat to serve the needs of all the units economically.

The servicing unit has been designed with a special purpose in mind; if used for that purpose, the unit will perform efficiently and economically. The result is a piece of equipment which will help pare the overall costs of the offshore operation. ★ ★ ★

Fig. 1. **Creole's new type drilling tender** is single-deck barge measuring 180 ft long, 70 ft wide and 11¼ ft deep.

In 1956, Creole Petroleum Corporation's offshore fleet grew with the addition of four...

New Lake Maracaibo Drilling Tenders

W. E. Harrelson,
Senior Drilling Engineer,
Creole Petroleum Corporation, Tia Juana, Venezuela

DRILLING barges used in the Bolívar Coastal field of Lake Maracaibo by Creole Petroleum Corporation, Venezuelan affiliate of Standard Oil Company (New Jersey), are of the floating platform type (tender type barge) upon which standard land type, skid-mounted drilling equipment is carried and operated.

In the late 1920s, the tender type barge was first used for offshore drilling in the Bolívar Coastal field. Barges of this type still are in use today, but the equipment, horsepower available and barge sizes have changed considerably.

With the tender type barge, shown in Fig. 1, the drawworks, engines, rotary, strung-up equipment, mud manifold, water manifold and standard derrick are supported on the well foundation which is either 24 by 24 ft or 30 by 30 ft. The foundation rests on concrete piles which are driven deep into the lake bed. When drilling, the barge is anchored on the side of the foundation from which the prevailing winds blow. Connections between the barge and foundation are the air, water, drilling mud and electrical lines, and the pipe ramp which is hinged to the foundation. During bad weather, all connections from the barge to the foundation are disconnected and the barge is pulled back and allowed to ride out any rough water conditions.

Size of barges. Drilling barge development has progressed considerably since 1929 when the first steam barge was used. That barge was 100 ft by 40 ft by 7 ft in dimensions. Creole now has standardized its drilling barges at 180 ft by 70 ft by 11¼ ft, (Fig. 1), and has changed from steam to diesel power. Barge hulls are of welded steel construction, and the design, material, and workmanship meet the requirements of the American Bureau of Shipping for the "Short Coastwise Service" category. All drilling barges are constructed with one rake end and one square end. Below deck, the barges are divided into water-tight compartments, drilling mud storage pits and fuel storage tanks. All barges purchased by Creole during the past several years have been constructed and equipped in the U. S. and then towed to Venezuela. In 1956, four new drilling barges of the Lake Maracaibo type were added to Creole's offshore fleet.

Barge details. At the present time, wells are being drilled at distances of more than 30 miles from shore and in water of 100 ft or more in depth. Operations in deep water, where wave action becomes severe, have forced the abandonment of the so-called double-deck type of barge that was used in shallower water. On the double-deck barges, mud pits were inside the barge hull. The first deck, or barge deck, was

Fig. 2. **Forward end of tender,** showing pipe deck and ramp, radio house at right, shale shakers and drilling rig foundation structure.

Fig. 3. **Rig power and pumps** are located on the aft end below the helicopter deck.

utilized for power generating equipment, mud pumps, water and fuel pumps. Mud ditches, shale shakers, blowout preventer closing unit and storage space for mud additives. The top deck was utilized for pipe, dog houses and storage space for miscellaneous drilling equipment.

The standardized barges now being acquired for Creole are single deck craft of dimensions given previously. Below deck in the barge hull are the reserve drilling mud pits and the suction pit (Fig. 5). Located on the first deck, or barge deck, from forward to aft, are the shale shakers, blowout preventer closing unit, radio house, pipe deck with a clear deck space for approximately 3450 sq ft, with walk ways and storage space located on port and starboard sides, bumper wall, manifold, dry sack goods storage facilities, change room, mud pumps, engine compound transmission, engines, anchor hoists, and generators. The roof over the aft portion of the vessel serves as a heliport, shown in Fig. 3.

Mud Pumps and Engines

Drilling barges acquired in recent years are classified in two groups, those rated at 1200-hp and those rated at 1600-hp. This grouping is based on continuous horsepower available to drive the main mud pumps. Emphasis has been placed on standardization of equipment, piping, fixtures, etc., in order to reduce spare parts and replacement inventories.

1200-hp barges. The 1200-hp barges are equipped with two main mud pumps (Fig. 4). Each pump is rated at 700-hp input. Power for the pumps is supplied by a group of three engines, compounded together, (Fig. 6), each of which has a continuous rating of 400-hp, making a total of 1200-hp available to drive the pumps. As stated, this is the figure Creole uses to rate the barge. Each engine drives through a torque converter. Connecting the output shafts of the torque converters and the main mud pumps is a three-engine compound transmission (Fig. 7). Through controls on the transmission,

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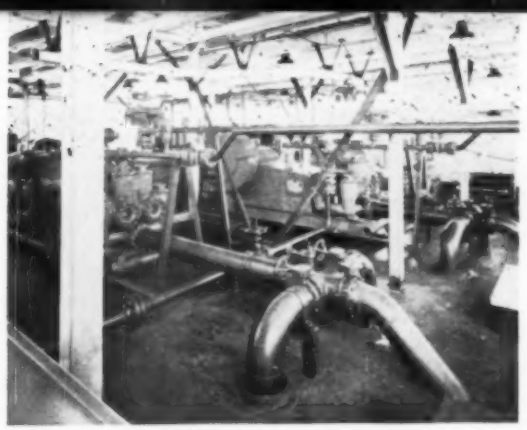

Fig. 4. **Main mud pumps** and suction piping are on main barge deck level.

Fig. 5. **Manifold and mud mixers** located above mud suction pits in hull.

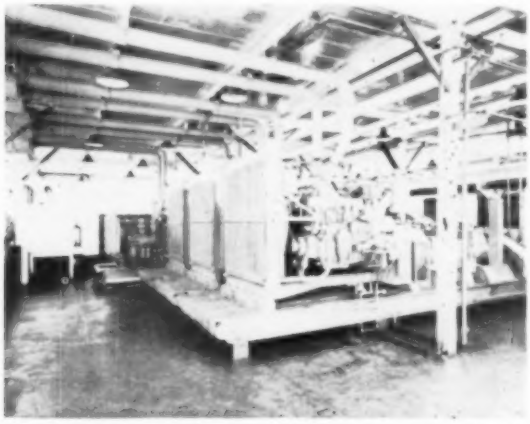

FIG 6. **Power plant** of 1200-hp barge is three 400-hp diesels.

Fig. 7. **Engine compound transmission** furnishes power to two main pumps.

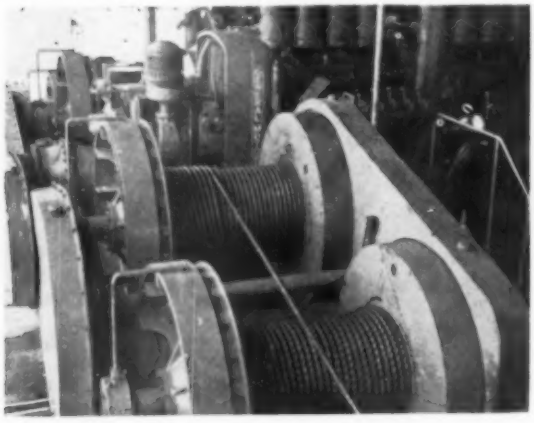

FIG. 8. **Anchor hoists,** independently driven by diesel engines hold drilling tender in position at location.

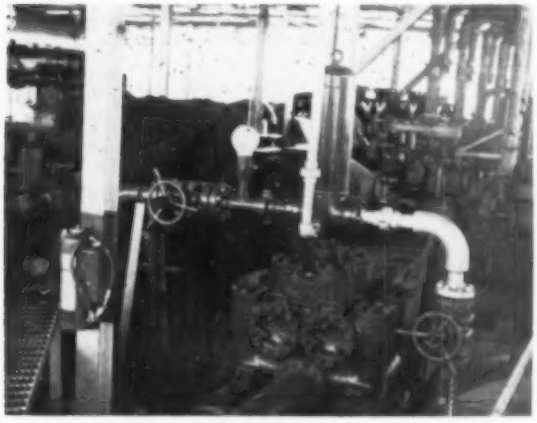

FIG. 9. **175-hp mud mixing pump** is driven by 260-hp diesel engine through torque converter.

either pump can be operated separately, or both can be operated simultaneously.

As a separate unit is a mud mixing pump (Fig. 8) which is rated at 175-hp input. This pump is powered by an engine with a continuous rating of 260-hp. The engine drives through a torque converter.

1600-hp barges. Drilling barges of the 1600-hp category are equipped with two main mud pumps, which are rated at 1000-hp input. These craft are equipped with four engines, also compounded together and also with a continuous rating of 400-hp each. As on the 1200-hp barges, each of the four engines drives through a torque converter, and the same degree of flexibility in operation is provided through the four-engine compounded transmission.

The mud-mixing pump and engines are identical with those on the 1200-hp barges.

Current Barge Strength

Creole now has 19 barges in operation on Lake Maracaibo. Four additional barges are being constructed at the Bethlehem shipyard at Beaumont, Texas, all on the same plan as is outlined above, except one which will be full diesel-electric. ★ ★ ★

EXPLORATION ACTIVITIES

CALIFORNIA

★ More than three-fourths of the lots in the Pico-Adams residential area (bounded roughly by Country Club Drive on the north, Vermont on the east, Jefferson on the south, and Longwood on the west) have been leased to three oil companies competing for potential oil producing property.

J. K. Wootan, Signal Oil and Gas Company land department head and director, said that his company has leased almost 5000 lots (more than either of the other competing firms) since it entered the leasing race early last February. He stated that there are approximately 13,500 parcels of land in the area where Signal is competing with Union Oil Company and Guiberson and Burke.

★ Santa Fe Drilling Company of Whittier as operator, spudded "KCL" No. 64X-26 Kern County, California, May 1. This is a joint 6000 ft test with Great Basins Petroleum Company on the east flank of the Fruitvale field adjacent to Bakersfield. Present production in the Fruitvale field is from the Etchegoin and Chanac sands. This deep test will be to the Stevens sand, which has been the source of several discoveries in the past year in the southern portion of the San Joaquin Valley. Great Basins has approximately 650 acres under lease on this play.

SICILY

★ After intensive geological and geophysical surveys, The British Petroleum Company's exploration subsidiary in Sicily is preparing to drill a second deep test well in southeast Sicily. The site of the new well is at Troitta, near Caltagirone. The well will be known as Troitta No. 1. BP's first test well in Sicily — drilled near Vittoria in 1953 and 1954 — found some crude oil but of very heavy specific gravity. Although no commercial outlet has yet been found for this oil, a prolonged production test is being planned in the hope that its further development can be undertaken to contribute to the supply of bitumen needed for the extensive program of road construction recently adopted in Italy.

INDIA

★ Standard-Vacuum Oil Company spudded-in its first wildcat well in India on April 18. This is Burdwan No. 1 West Bengal, which is located about three and one-half miles east of Burdwan and approximately 30 miles northwest of Calcutta. The text was reported at 671 ft on April 20. The drilling contractor, Southeastern Asia Drilling Company, a subsidiary of Southeastern Drilling of Dallas, is prepared to drill to 10,000 ft. Burdwan No. 1 is situated in a 10,000-sq mile concession established under the Indo-Stanvac Petroleum Project pact signed in New Delhi in December 1953. Under this agreement the government provides one-quarter of the exploration expense and Stanvac pays the other three-quarters of the cost and manages the join operation. Stanvac conducted an extensive aerial magnetometer survey of the area in 1951 before the pact was negotiated. The agreement then opened the way for detailed surface investigations. The well site was chosen after extensive geophysical preparation including gravimetric and seismic work.

VENEZUELA

★ A group of five U. S. oil companies have been officially advised by the Ministry of Mines and Hydrocarbons of Venezuela of the acceptance of their bids for exploitation concessions on six lots comprising a block of approximately 150,000 acres in the Venezuelan waters of the Gulf of Paria, lying between the Venezuelan mainland and the island of Trinidad. Bids for the concessions totaled $100,000,000. The group and their respective percentages of participation include Continental Oil Company, The Ohio Oil Company, and The Texas Company, 25 percent each; Cities Service Oil Company, 16⅔ percent; and Richfield Oil Corporation, 8⅓ percent. With the exception of Richfield, the interests will be held by wholly owned subsidiaries of the companies. Bids were filed February 11 on behalf of the group by Continental Oil Company of Venezuela.

KANSAS

★ Great Basins Petroleum Company of Denver and Los Angeles has made location for No. 1 Commercial Bank, NW NW SW Section 23-1s-27w, Decatur County. This well is the first of a two-well program designed to test a large stratigraphic trap in the wedge-edge of the Arbuckle dolomite and the Reagan sandstone. The Lansing-Kansas City groups and the lower Cherokee sands are secondary objectives. The well will bottom in granite at an estimated depth of 3850 ft. It is located about 10 miles northeast of Oberlin.

ARKANSAS

★ The Hummingbird Drilling Company (Houston and Magnolia, Arkansas) announces completion of a well in an extension to the Smackover, Arkansas, Snow Hill field. The well is producing 130 bbl every 24 hours through a 10/64-in. choke and completion was made between 3490-3497 ft. Other indicated pay areas are under test. Hummingbird obtained the lease on a farmout from Don Packer and the McAlester Fuel Oil Corporation. Other interested parties are Horizontal Holes, Inc., a division of Bortunco, Houston, and R. T. Mobley, Odessa, Texas.

LOUISIANA

★ The Texas Company announced its deepest pay strike in South Louisiana upon the completion of a 346 bbl-a-day well at 16,303 ft as a major extension of the south flank of Lake Barre field in Terrebonne Parish. An on-structure wildcat, the Texaco Louisiana Land and Exploration Company State of Louisiana Unit 38-1 was perforated in the Miocene at 16,303-16,326 ft and flowed at the rate of 346 bbl daily through an 11/64-in. choke. Tubing pressure was 4950 psi gravity of the oil 45.4 deg and the gas-oil ratio, 7127 to one. Total depth of the drilling was 16,573 ft. The nearest production to the Unit 38-1 is over one mile north in Lake Barre field.

★ Monterey Oil Company reports the completion of State No. 2, located in the Lake Boeuf field in Lafourche Parish. This well was drilled to 13,200 ft and brought in flowing from the interval 13,122 to 13,130 ft, at a rate of 288 bbl per day of 33.5 deg oil through a 10/64-in. choke. On test the well produced with a gas oil ratio of 757 cu ft per bbl, and with a tubing pressure of 1400 psi.

State No. 2 is located a mile west of the field discovery well, completed by Monterey in October 1956, and marks an important extension of the productive area of the field. The well logged 612 ft of sand between 8372 and 13,130 ft, a total of 258 ft of which is either oil or gas and condensate sand. The particular sand in which the well was completed is approximately 100 ft thick. Monterey and Kern County Land Company hold jointly a 50 percent interest in these Lake Boeuf leases and this is the third producing well completed on their properties. Additional wells are scheduled.

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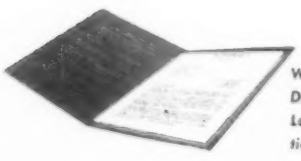
Obtaining the answers to a number of basic questions regarding a specific reservoir and its present operations is your practical approach to the problem. Simply write Core Lab, Dept. SD, Box 10185, Dallas. Give a brief description of the reservoir. Competent engineering personnel will process your inquiry.



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DRILLING TENDERS

Become 'Out-of-Stock' Item

Lake Maracaibo type tenders now available fully equipped and ready for operation . . . all in one package

PROSPECTS for increased drilling activity on Lake Maracaibo in Venezuela has brought about a new idea in oilfield supply company operations. Fully equipped and finished offshore drilling tenders as well as a complete drilling rig are now available "out-of-stock" for the first time. It is no longer necessary for the drilling contractor or an oil company to contract for the design of a tender barge at one place, have it constructed at another, then purchase the equipment from more than two dozen different sources. The Continental-Emsco Company of Dallas, Texas, has already done all these chores and are providing a "packaged" unit ready to go to work. While the tenders are of the Lake Maracaibo type, their use is not limited to this area.

The first such tender, built by Levingston Shipyard Company at Orange, Texas, was sold to Kerr-McGee Oil Industries, Inc., of Oklahoma City for use in drilling in Lake Maracaibo on a concession in which the drilling contractor has an interest. The new tender was named Kermac V-1. This is the first of several units to be fabricated and made available to the oil industry.

The "out-of-stock" drilling tender measures 180 ft long, 70 ft wide and 11¼ ft deep. A helicopter deck 45 ft by 83 ft is included.

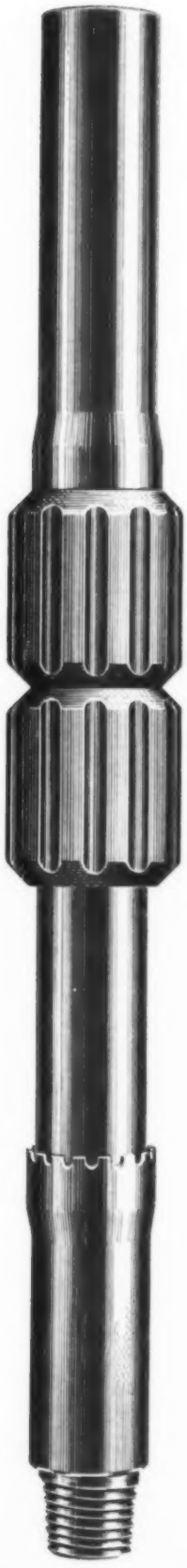
Rig power might be classified as diesel-mechanical-electrical, in that the mud pumps located on the tender are driven through a power transmission unit connected to diesel engines. Electrical generators are also driven off the power transmission, which generators furnish power to the drawworks electrical motors.

The tender is equipped with two 1000-hp, 7¾ by 18-in. mud pumps, driven through electric couplings off a power transmission unit, three 500-hp diesel engines, a 250-hp 7¼ by 14-in. mud mixing pump driven by a 250-hp diesel engine, two d-c generators rated at 600-hp maximum input and driven by the power transmission, a 5 by 6-in. water pump and two 100-kw a-c generators driven by 150-hp diesel engines.

Lake Maracaibo type tender nearing completion at Levingston Shipyards in Orange, Texas, prior to shipment to Venezuela. These units will be stock items.

Drilling equipment located on the platform consists of a drawworks rated for 7000 to 11,000-ft drilling with 4½-in. drill pipe, driven by two d-c traction-type electric motors rated at 625-hp continuous. The drawworks has four hoisting speeds and two rotating speeds. The drawworks is rated at 1100-hp input. Operating controls are of the conventional power rig type mounted on a sliding console at the driller's position. The drawworks is equipped with a 46-in. hydraulic brake. Other drilling equipment includes a 400-ton swivel, a 450-ton traveling block, a 450-ton crown block, a 350-ton hook, a 27½-in. rotary table and a 5¼-in. by 40-ft kelly.

Continental-Emsco has established supply and service centers in Venezuela to service and maintain the Lake Maracaibo type tenders and equipment. ★



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What's doing in DRILLING

★ **Automation in drilling** is already capable of cutting drilling time and costs, say W. C. Gresham and R. H. Ashby (Mud Control Laboratories), O. E. Mechem and K. J. Ward (Delta Drilling Company). The foursome pointed out several savings in an API paper on automation presented in Denver recently. Their studies showed that automatic weight-control equipment on rotary drilling rigs enabled improvement in penetration rates varying from 7 to 50 percent; and savings in rock bits from 29 to 50 percent. Their conclusions were that continued application of automatic weight control would point to widespread savings and advantages by the drilling industry.

★ **Conferences for Drilling Executives** series have wound up its second successful season. Three quite well attended meetings were held in April and May. This year's three-day conferences were held in Lafayette, Louisiana, Wichita, Kansas, and Houston, Texas. Over 200 leading oil men have attended the nine American Association of Oilwell Drilling Contractors-sponsored meetings in 1956 and 1957. Last of the meetings was at Houston, May 22-24.

★ **Drillers' union plans** are ambitious, as has been evidenced by activities in Louisiana, Texas, and California, during May. The International Union of Operating Engineers, local 672, after three years of obscurity, is showing new strength by shutting down a Sun Marine Drilling Company rig in California, picketing of three rigs in the Permian Basin, and organizing efforts in South Louisiana. Two rigs of Cactus Drilling Company and one of Denver Drilling Company, operating in Borden County, were struck in May. Texas Rangers were called out to "keep the peace." Union officials in Morgan City say organizing is well underway among the offshore drilling crewmen. Union now has 16 organizers operating in the major oil areas, officials state.

★ **Kerr-McGee Oil Industries, Inc.,** is scheduled to enter the contract drilling picture in Venezuela late this summer, with two Lake Maracaibo type drilling tenders under construction at Orange, Texas. Kerr-McGee will establish an office in Maracaibo. Heading the company's Venezuelan operation will be Leo LeBron, at present Kerr-McGee marine superintendent. First of two tenders being built by Levingston Shipbuilding Company of Orange is scheduled for delivery in mid-June. This tender will drill under contract to a group of American companies headed by Sun Oil Company. The second tender, scheduled for delivery in late July, will drill for another combine of American companies, including Kerr-McGee, of which Phillips Petroleum Company is the largest interest holder and is the operator.

★ **Cable tool drilling** memories were revived in Kern County, California, recently as 1600 persons from the state's various oil provinces gathered to dedicate a reconstructed cable tool rig in the Pioneer Village. The rig is an exact replica of the kind that was responsible for opening much of Kern County's oil production. Aiding in bringing the historic equipment to the display area were the Petroleum Producing Pioneers, the Kern County Board of Supervisors and the Kern County Museum Oil Committee.

★ **Humble Oil & Refining Company** is to begin drilling immediately on a 12,000 ft test at Cold Bay in the Kanatak area of southwestern Alaska. Venture is a joint agreement between Humble and Shell Oil Company, with Humble acting as operator. Outside the Kanatak area, Shell and Humble will continue exploration work individually in Alaska.

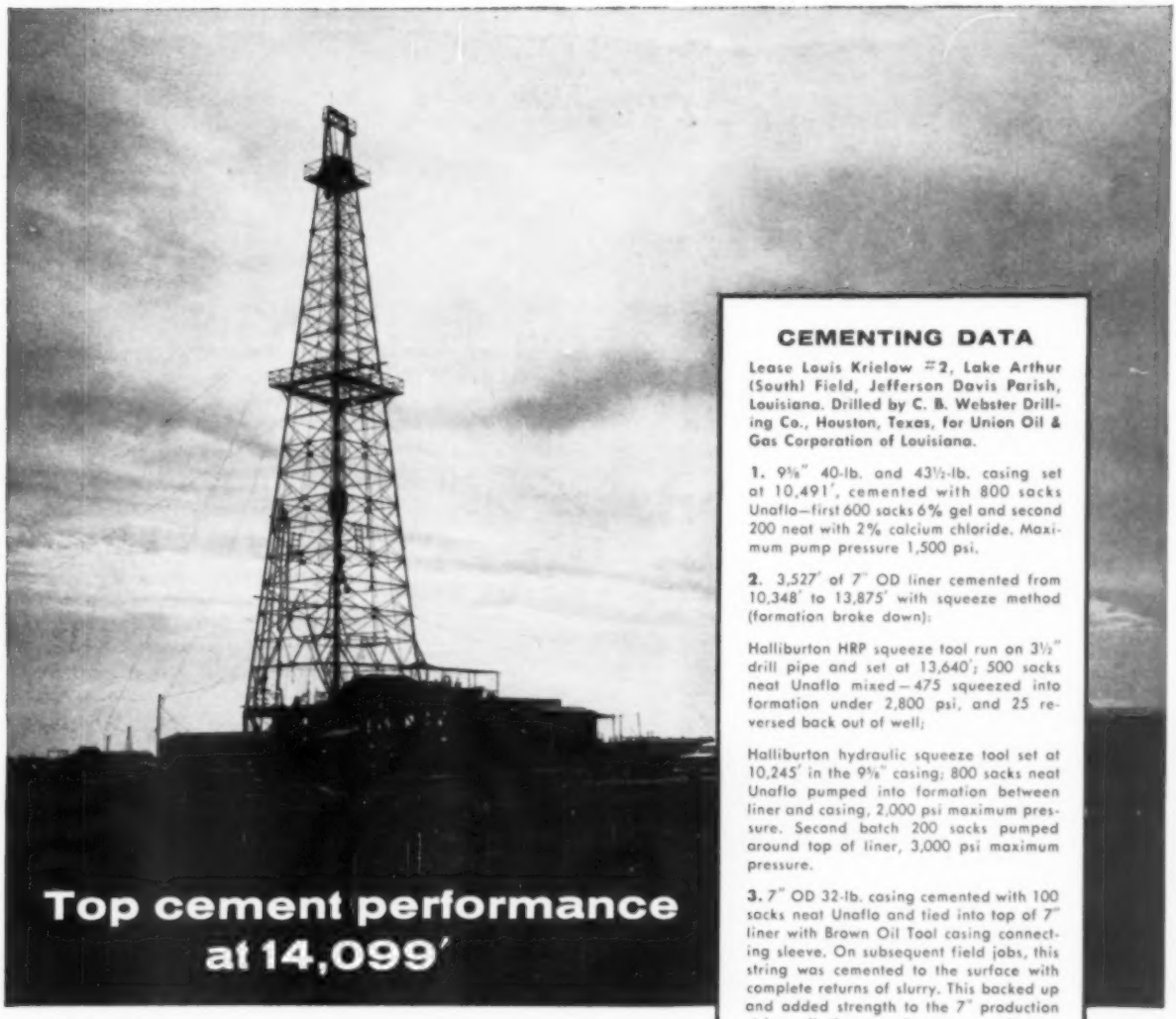
★ **Greenland Drilling Company,** formerly of Wichita, Kansas, has moved to Kansas City, Missouri. The headquarters move was recently announced by Greenland's president, George H. Bunting, Jr., and Oscar Bridge, vice president, the owners. Bridge will operate from Great Bend, Kansas.

★ **In Pennsylvania,** legislation has been introduced to give its Department of Forest and Waters jurisdiction over offshore drilling in that state's portion of Lake Erie. Contemplated leases will be similar to that for forest lands, but adapted for offshore operations. Initial blocks will be five-minute rectangles and leases will require a test to the Trenton, no water pollution and subsurface completions, among other clauses. The department to receive the responsibility for the offshore program now owns 2,000,000 acres of land in Pennsylvania, overseeing the leasing of its properties, using both royalty and rental bases.

★ **Fifty drill sites** have been selected in southeast Saskatchewan in a new development and exploration program to be supervised and operated by Gridoil Freehold Leases, Ltd. The Calgary based subsidiary of Anglo American Exploration Ltd., announced the signing of a development agreements providing $3,000,000 for the drilling of Gridoil's lease holdings. Drilling contracts are now being arranged for immediate start of this program and the first two sites have been selected for drilling in the Weyburn-Colgate area. S. C. Nickle, president, said he believed that this was the first limited farm-out secured by proved production in place that has ever been made.

★ **Brown Drilling Company** and its subsidiaries, among the larger West Coast drilling contractors, has been sold to European interests. Societe Financiere de Transports et d'Enterprises Industrielles (Sofiana), Brussels, Belgium, and interests represented by Lazard Freres & Cie., Paris, France, acquired Brown and its two subsidiaries, Brown Marine Drilling Company and International Brown Drilling Corporation. International Brown is currently operating three rigs in Venezuela and one in Turkey and another due there soon. Brown Marine is drilling on the Monterey-Texas Company artificial island offshore Long Beach, California. New owners of the Brown organization plan immediate expansion of operations, particularly in France, Turkey and Venezuela. Terms of the sale have not been disclosed.

★ **Another Oklahoma area** is to be opened to the deep drill. Shell Oil Company has announced plans to drill a projected 17,000 ft geological wildcat in the Elk City field of Beckham County in the southwestern part of the state. New venture is on a lease that has four wells producing at a depth of about 10,000 ft.



CEMENTING DATA

Lease Louis Krielow #2, Lake Arthur (South) Field, Jefferson Davis Parish, Louisiana. Drilled by C. B. Webster Drilling Co., Houston, Texas, for Union Oil & Gas Corporation of Louisiana.

1. 9⅝" 40-lb. and 43½-lb. casing set at 10,491′, cemented with 800 sacks Unaflo—first 600 sacks 6% gel and second 200 neat with 2% calcium chloride. Maximum pump pressure 1,500 psi.

2. 3,527′ of 7" OD liner cemented from 10,348′ to 13,875′ with squeeze method (formation broke down):

Halliburton HRP squeeze tool run on 3½" drill pipe and set at 13,640′; 500 sacks neat Unaflo mixed—475 squeezed into formation under 2,800 psi, and 25 reversed back out of well;

Halliburton hydraulic squeeze tool set at 10,245′ in the 9⅝" casing; 800 sacks neat Unaflo pumped into formation between liner and casing, 2,000 psi maximum pressure. Second batch 200 sacks pumped around top of liner, 3,000 psi maximum pressure.

3. 7" OD 32-lb. casing cemented with 100 sacks neat Unaflo and tied into top of 7" liner with Brown Oil Tool casing connecting sleeve. On subsequent field jobs, this string was cemented to the surface with complete returns of slurry. This backed up and added strength to the 7" production string all the way from top to bottom of well.

Bottom-hole (Log) temperature at 14,000′ 243° F. Mud weight 17.5 lbs. per gal. (Funnel) viscosity 63 (seconds).

ATLAS UNAFLO* oil-well cement

- On deep jobs like this, oilmen have learned to rely on Unaflo retarded oil-well cement to go into place without a hitch.
- Slurries pump easily, stay fluid and pumpable under severe conditions of temperature and pressure.
- UNAFLO's *retarded set* gives vital extra time in emergencies, yet slurries form a strong, watertight, sulphate-resistant seal.

For typical data tables write:
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*"UNAFLO" is the registered trademark of the retarded oil-well cement manufactured by Universal Atlas Cement Company.

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★ **Rain in North and East Texas** in early May sent drilling activities in the U. S. and Canada to its lowest level in over six years. Unceasing rains in North Texas and flooding in East Texas were held responsible for stacking (if the rigs could be reached to stack) at least 120 rigs in the week ending May 6. U. S. and Canadian total during that week was 2355 working rotaries — lowest level since January 8, 1951, when 2333 rigs were operating.

★ **Pennant Drilling Company** is now officially a part of Canadian Homestead Oils, Ltd., on approval of the stockholders. Canadian Homestead exchanged 850,000 shares of its common stock for the entire capital stock of Pennant. Crescent Corporation, principal stockholder of Pennant, acquired 642,625 shares, or about 24 percent of the shares outstanding, in Canadian Homestead. Clinton E. Wright is president of Pennant.

★ **Merger** of Rimrock-Tidelands, Inc., of New Orleans, and Trans-Tex Drilling Company of Shreveport was announced recently in a joint statement issued by W. O. White, president of Trans-Tex and H. L. Rowley, chairman of the board of Rimrock Tidelands. Rimrock-Tidelands is to be surviving company. The merger has been approved by the Board of Directors of both companies, and is now being submitted to the stockholders for ratification. Merger of these two companies results in an organization with assets of $7,000,000 and is active in exploration, production and offshore and onshore drilling operations. Trans-Tex Drilling Company is a wholly owned subsidiary of Husky Oil Company of Cody, Wyoming. Chairman of the board of Trans-Tex is George S. Buchanan who will become chairman of the Board of Rimrock-Tidelands; H. L. Rowley, present chairman of the board of Rimrock-Tidelands, will become president of the new company; W. O. White, now president of Trans-Tex Drilling Company, will become vice president in charge of Land and Production; and W. C. Kneale, now president of Rimrock-Tidelands, will become Vice President in charge of Exploration. Trans-Tex operates three drilling rigs in Alabama and Mississippi. Rimrock operates inshore and offshore drilling rigs and carries on exploration in the Gulf Coast. It now owns and operates two platform drilling rigs offshore and is negotiating for other platform and barge equipment for an extensive expansion in offshore operations.

★ **New foreign drilling firm** has been formed, the Keir and Cawder Arrow Drilling Company, Ltd., by Arrow Drilling Company of Tulsa, Oklahoma, and Keir and Cawder of London, England, and Glasgow, Scotland. New organization will drill in Europe, Africa, the Middle East and Far East. Drilling operations will be handled by Arrow personnel under direction of Lloyd Hanson, Arrow's superintendent. Keir and Cawder Ltd. is an old firm of consultants, designers and manufacturers and is responsible for construction of several large road, dam, bridge and airport construction in the areas where the new organization will drill. Offices have been set up in Tulsa and in Glasgow, Scotland. Arrow and its Canadian branches operate 21 rigs.

★ **Road bans in Western Canada** slowed drilling operations in May. Effective May 6, 120 rigs were in operation and 7 were reported rigging up. Alberta reported 80 rigs of the total, 15 more than the week previous, but still below normal. Road bans are being lifted daily in the southern and central parts. Exploration operations in the north, however, have been on the rise in recent months, were reported near a standstill until local road conditions can be alleviated.

Rotary Rigs Operating in Oil Fields of United States and Canada*

	March 18	March 25	April 1	April 8	April 15	April 22	April 29	May 6	May 13
Alabama	14	12	12	11	12	8	11	11	9
Arkansas	19	20	20	18	19	19	23	18	21
Arizona	0	0	0	0	1	1	1	1	0
California	96	96	94	91	89	85	89	94	93
Colorado	40	37	39	36	37	34	40	37	43
Florida	1	2	2	2	3	3	2	1	1
Georgia	1	1	1	1	0	0	0	0	0
Idaho	0	0	0	0	0	0	0	0	0
Illinois	51	43	34	37	34	44	51	61	80
Indiana	6	5	6	4	6	7	4	8	6
Iowa	1	2	2	2	2	2	2	2	2
Kansas	166	169	130	106	154	164	169	154	166
Kentucky	7	6	3	3	3	4	5	10	10
North Louisiana	53	51	51	47	59	53	53	52	54
South Louisiana—Land	274	281	265	266	266	269	266	258	263
South Louisiana—Offshore	100	99	97	103	95	96	101	101	102
Total Louisiana	427	431	413	416	420	418	420	411	419
Maryland	1	1	1	1	1	1	0	0	0
Michigan	10	7	11	12	9	13	10	14	13
Missouri	0	0	0	0	0	1	1	1	1
Montana	27	24	27	26	25	27	25	26	27
Mississippi	19	19	20	33	32	30	34	30	31
Nebraska	30	30	30	35	30	30	41	44	39
Nevada	0	0	0	0	0	0	0	0	0
New Mexico	116	124	128	132	144	141	136	145	140
New York	1	1	1	1	1	1	1	1	1
North Dakota	24	22	26	21	23	23	25	24	24
Ohio	0	0	0	0	0	0	0	0	1
Oklahoma	250	231	203	223	248	247	221	198	239
Oregon	1	1	1	1	1	1	1	1	1
Pennsylvania	10	13	13	10	13	10	11	13	13
South Carolina	0	0	0	0	0	0	0	0	0
South Dakota	2	1	2	2	1	2	2	2	1
Tennessee	0	0	0	0	0	0	0	0	0
Texas Gulf Coast—Land	223	213	219	218	225	225	186	196	198
Texas Gulf Coast—Offshore	6	7	8	7	5	3	6	5	8
West Texas	398	403	417	423	416	396	378	371	374
North Texas	372	350	335	359	373	349	321	215	286
East Texas	53	47	53	57	56	56	57	43	41
Total Texas	1,052	1,020	1,032	1,064	1,075	1,031	948	830	907
Utah	31	31	26	28	32	31	34	36	32
Washington	0	0	0	0	0	0	0	0	0
West Virginia	1	1	1	1	1	1	1	1	1
Wyoming	46	46	49	44	47	53	64	59	62
Total United States	2,450	2,396	2,327	2,361	2,463	2,432	2,372	2,233	2,383
Western Canada	243	225	181	130	108	99	101	120	158
Eastern Canada	0	0	0	0	0	0	2	2	2
Grand Total	2,693	2,621	2,508	2,491	2,571	2,531	2,475	2,355	2,543

*As reported to the American Association of Oilwell Drilling Contractors by Hughes Tool Company.

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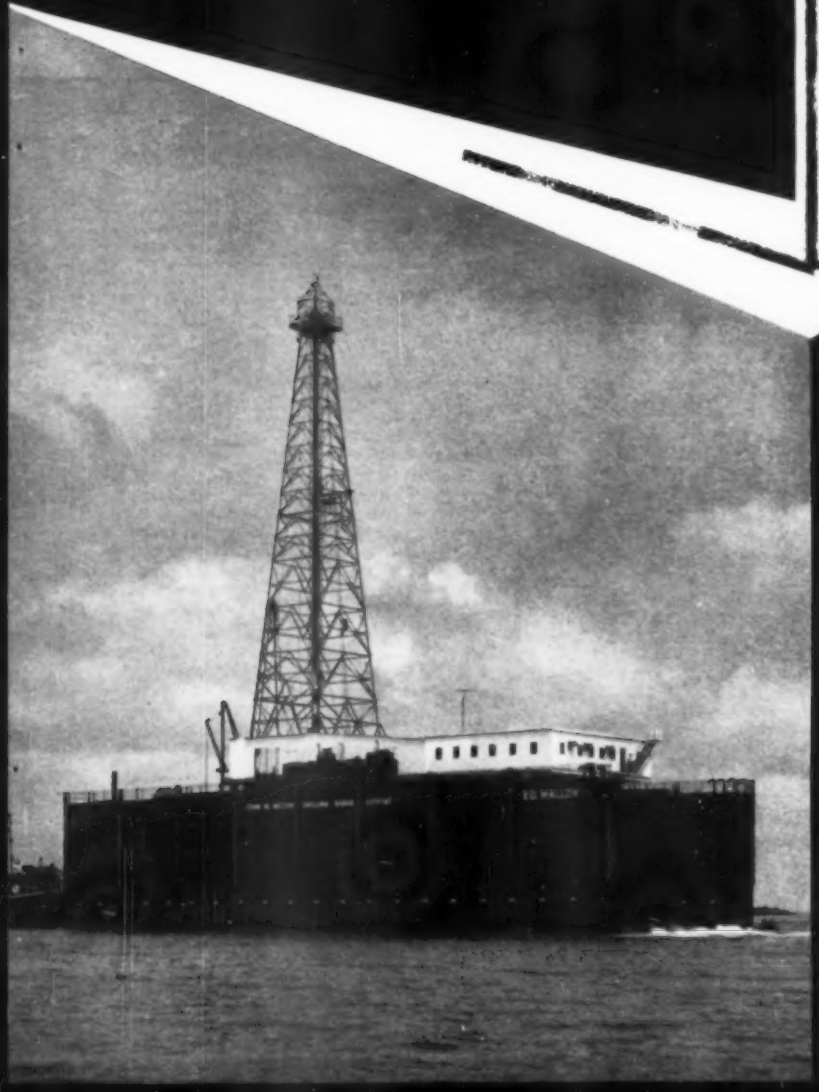

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RUNNING TOUR with MEN in the INDUSTRY

Dr. Rein de Wit has been named senior research geologist, Calgary, Alberta, for Sohio Petroleum Company. His former position was district geologist, Calgary. Replacing de Wit as district geologist, is **Dr. Thomas Parks,** formerly senior geologist.

C. J. Stanberry, Corpus Christi, Texas, has been promoted to superintendent of Continental Oil Company's Louisiana production division, with headquarters at LaFayette, Louisiana. Formerly Texas Gulf Coast division production superintendent at Corpus Christi, he succeeds the late W. J. Lueck.

Also **C. A. Ward,** Lafayette, assistant division production superintendent, has been promoted to superintendent of Conoco's Texas Gulf production division at Corpus Christi, succeeding Stanberry.

William H. Wildes of Dallas, Texas, president of Republic Natural Gas Company, has been named chairman of the board and **C. C. Miller,** vice president, has been moved up to the presidency. Wildes is the first board chairman in the history of the concern. He had been president since Republic Natural was incorporated. Miller, who recently joined the company as vice president, previously had been associated with Harper-Turner Oil Company and prior to that, had been executive vice president of British-American Oil Producing Company.

Tidewater Oil Company has announced the following personnel changes in the West Texas-Southwest New Mexico area. **H. J. Tuffy Jr.,** area engineer at Spraberry, named to the same post in Odessa, replacing **R. E. Neely,** who is transferred to Kamay. **D. W. Rice,** former senior field engineer in Hobbs, New Mexico, replaces Tuffy.

Ralph H. Viney, a petroleum engineer, has been elected an assistant vice president of The First National Bank, Fort Worth, Texas. A native of Bon Accord, Alberta, Canada, Viney has worked as petroleum engineer for several Texas oil companies. He formerly was with The First National City Bank of New York where he has been since 1956.

R. H. Viney

J. P. Weichert

J. P. Weichert has been appointed zone superintendent of production, Pierce Junction Zone, Gulf Oil Corporation. This covers production operations in South and southeast Texas and the coastal area from Beaumont to the Mexican border. He was in South Louisiana as district petroleum engineer, prior to returning to Pierce Junction as assistant zone superintendent of production.

Fred C. Boucke has been appointed manager, Eastern Hemisphere staff and **E. P. Fay Jr.,** assistant manager of Standard Oil Company of California. Boucke, who has had extensive experience in foreign oil activities, most recently represented the company during negotiations leading to establishment of the Iranian Consortium. Fay has been associated with the Eastern Hemisphere staff as senior and supervising analyst.

Thomas R. Houghton has been elected treasurer of Brantly Drilling Company, Inc. Also, **Nancy D. Brantly** has been elected secretary to replace **Murphy H. Baxter.**

Albert Gregersen has been elected vice president, Gulf Eastern Company, a subsidiary of the Gulf Oil Corporation. He was formerly staff representative for Eastern Hemisphere production.

Gerald T. Pearson of Fort Worth has been named Texas Oil Information Committee regional vice chairman. He will guide the oil industry's public information and service program in seven OIC areas, which cover 110 counties in North and West Texas.

S. A. Berthiaume has been appointed an assistant to the vice president in charge of The Texas Company's domestic producing department. Berthiaume, who was assistant general manager of the department at Houston, Texas, since January 1954, assumed his new duties in New York City on May 1.

T. L. Kunkel has been promoted to chief geophysicist of the producing department. He was formerly named assistant division manager of the geophysicial division. **George H. Clark** was promoted to assistant to general manager of the producing department. It also was announced that **O. B. Hocker** will succeed Clark as assistant division manager, South Texas division of the department. Both will be located at Houston.

Promotion of three men to key positions in Continental Oil Company's land offices in Salt Lake City, Utah, and Denver, Colorado, have been announced. **Arthur P. Lorfing,** former assistant regional land superintendent at Denver, promoted to division land superintendent, with headquarters at Salt Lake City. **Melvin E. Thrash,** assistant division land superintendent at Billings, Montana, promoted to assistant regional land superintendent at Denver, succeeding Lorfing. **Kenneth A. Mead,** division land superintendent at Salt Lake City, assigned special duties in Continental's regional land headquarters in Denver.

George B. Magruder Jr., a veteran in the oil industry and a vice president of Southern Production Company, Inc. until the acquisition of its oil and gas properties by Sinclair Oil & Gas Company, has resigned from an executive position with Sinclair to enter the oil business as a consultant and operator. Magruder will open offices in Fort Worth, Texas, shortly.

Canadian Bishop Oil, Ltd., has announced the addition of **Robert R. Williams** to its Calgary staff as geologist under **Rex Barnes,** division geologist.

Robert Ford, consulting geologist, and **Blake Fox,** petroleum geologist, have formed the firm, Ford and Fox in Riverton, Wyoming. They specialize in the

Robert Ford

Blake Fox

fields of mining and petroleum. Also associated with the firm are **Robert Beseda** and **Jack O'Leary. Carolyn Boeh** is secretary.

John O. Hills has been advanced to the position of assistant to the director of production, General Petroleum Corporation. **Charles F. Gates,** formerly chief production engineer, succeeded Hills in the position of assistant manager of the production engineering and equipment section. **Donald F. J. McIntosh,** resident engineer at Ventura, was named assistant to the superintendent of production of the Ventura division. He is replacing **Donald B. Priest** who will work on special assignments in his new post as special assistant in the production department.

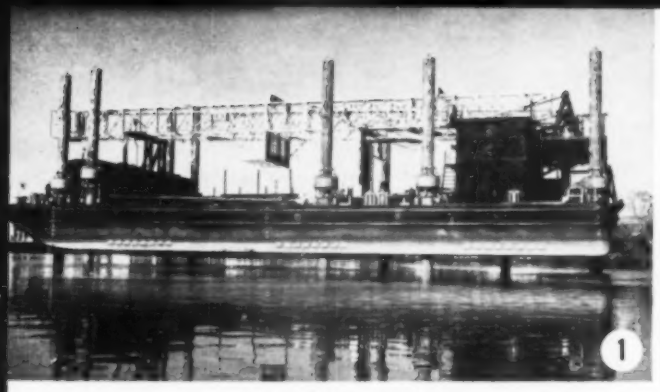
Other appointments included:

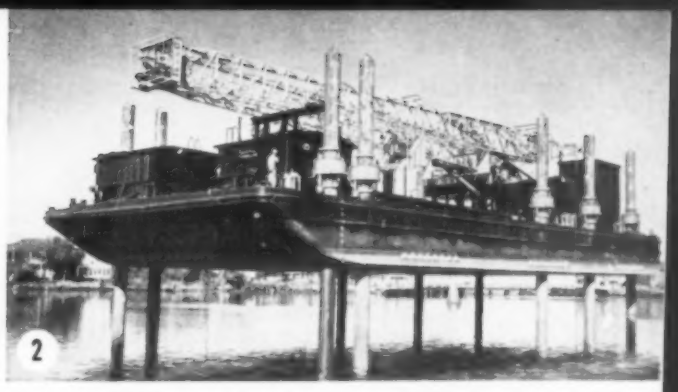
F. L. Wadsworth from chief petroleum engineer to assistant manager, petroleum engineering section; **C. L. Doyle,** from assistant chief petroleum engineer to chief petroleum engineer; **K. B. Green,** from research engineer to senior engineer and **R. L. White,** from laboratory engineer to research engineer.

J. R. Butler, a partner in Butler, Miller & Lents, consulting petroleum engineers and independent oil operators, was elected president of the Petroleum Club of Houston (Texas). He succeeds **Michel T. Halbouty,** also a consulting petroleum engineer, geologist and independent oil operator. Other new officers named are **Sidney A. Adger,** first vice president; **A. L. Selig,** second vice president; **Howard C. Warren,** secretary; **Joseph B. Kennedy,** treasurer, and **Walter G. Sterling,** assistant secretary-treasurer. New members of the board are **E. D. Brockett,** Warren, Kennedy and Sterling.

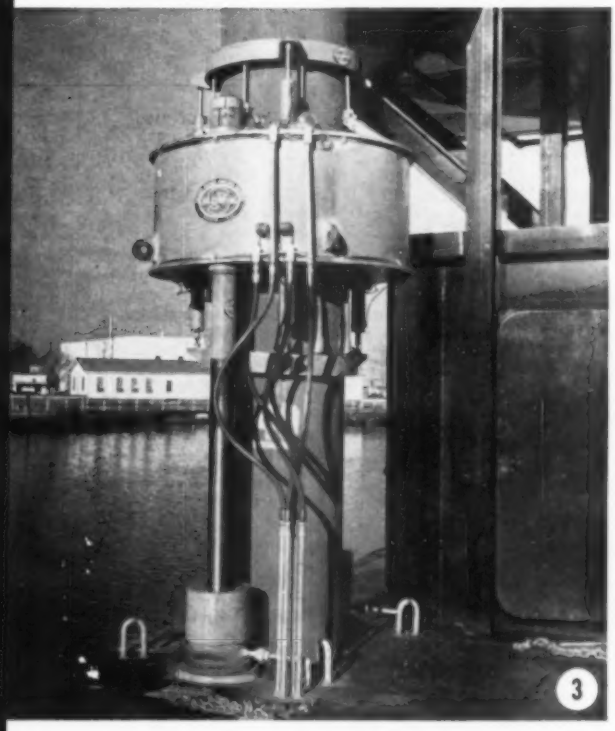
J. S. Boylan, Ponca City, Oklahoma, safety director for Continental Oil Company, was presented a certificate of appreciation at the mid-year meeting of the safety and fire protection committee of the American Petroleum Institute at Kansas City, Missouri.

O. D. Thomas has been advanced to the newly created position of foreign exploration director in Phillips Petroleum Company's foreign department. **J. R. Leonard,** formerly division exploration geologist at Amarillo, Texas, succeeds Thomas as southwest regional geologi in the land and geological department at Bartlesville, Oklahoma.





BIG BARGE . . . SPUD JACKS



Custom-built hydraulic jacks for every offshore requirement are specialties of

JOE STINE, INC.

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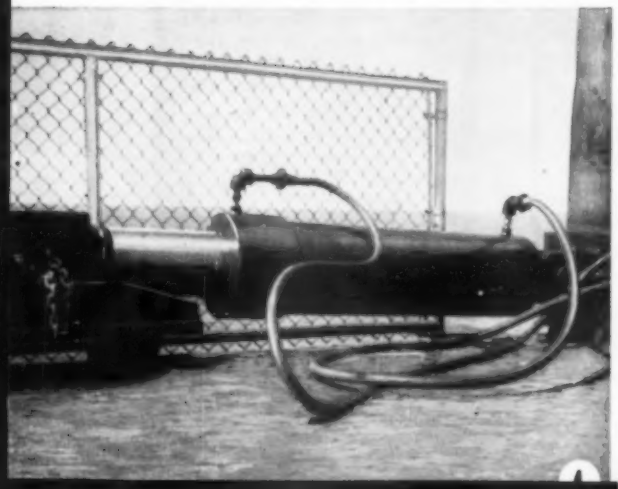
1. **Spud jacks begin to operate.**
2. **Barge can be raised to any desired height.**
3. **This unit has 4 ft. piston stroke.**

RIG SKIDDING JACKS



4. **Rig skidding jack at work.**
5. **When not in use, jack is swung up against sub-structure leg.**

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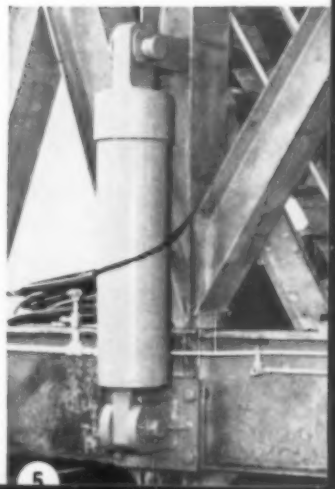
WRITE FOR OUR NEW CATALOG



Running Tour

▸ Humble Oil & Refining Company's production department announced the following personal changes.

R. R. McCarty, former assistant superintendent of the Southwest Texas division in Corpus Christi, was named superintendent of the western division in Midland. McCarty replaces **J. W. House,** who resigned recently. **R. C. Granberry,** former assistant chief petroleum engineer in the petroleum engineering division, Houston office, replaced McCarty as assistant superintendent of the southwest Texas division. **O. L. Furse,** former assistant division superintendent of the East Texas division, was named superintendent of the eastern division in New Orleans, Louisiana, succeeding **S. S. Langford,** who is no longer with the company. **John G. Calvert** succeeded Furse as assistant division superintendent of the East Texas division, and **H. H. Meredith Jr.** became East Texas division petroleum engineer, replacing Calvert. **R. L. Pinion Jr.** was transferred from the southwest Texas division office in Corpus Christi to the civil engineering division, Houston office, as a division civil engineer.

▸ **Richard T. Churchill,** Fort Worth, Texas, attorney, will join Neville G. Penrose, Inc. and its affiliated companies as secretary and general counsel. He is also associated with J. L. Tatum, geologist of Durango, Colorado, in the development of oil properties in Colorado and the Four Corners area.

R. T. Churchill

L. J. Stow

▸ **Louis J. Stow** has been elected secretary-treasurer of Nortex Oil & Gas Corporation. He succeeds **William G. Proctor,** who recently resigned. For nine years in Dallas, Texas, and 12 years previously in Philadelphia, Pennsylvania, Stow served as supervising accountant for Lybrand, Ross Bros. & Montgomery, resigning to join Nortex.

▸ **J. M. Clevenger,** district production superintendent for Sinclair Oil & Gas Company at Big Spring, Texas, has been promoted to assistant division superintendent for Sinclair's offshore division and transferred to New Orleans, Louisiana.

Robert A. Bonnell Jr., assistant district superintendent at Odessa, Texas, gas promoted to district production superintendent and transferred to Big Spring to succeed Clevenger. **Cuyler G. Confer,** intermediate petroleum engineer at Hobbs, New Mexico, was promoted to assistant district production superintendent and transferred to Odessa.

▸ **Lysle R. Kirk** has been promoted to chief geologist, Ohio Fuel Gas Company, replacing **K. C. Cottingham** who has retired. Kirk has worked for the past 20 years in the geological department.

▸ Gulf Oil Corporation today announced three top-level personnel transfers in its production department.

The new assignments will bring to Pittsburgh **E. D. Brockett Jr.,** vice president and manager of Gulf's Houston, Texas, production division. Brockett will become coordinator, production department, in Pittsburgh, Pennsylvania. **S. G. Sanderson,** vice president, and manager of Gulf's Tulsa production division, will become manager, Houston production division. **N. C. Simpson,** operations coordinator for the Western Hemisphere, production department in Pittsburgh, will become manager, Tulsa production division.

▸ Awards for 195 years of service were recently presented to 15 members of the Dallas, Texas, staff of Geophysical Service Inc. Those with twenty years service include **J. E. Huffstutler, E. E. Keese, E. A. Kiesler, R. D. Everett,** and **R. M. Sacksteder.** Fifteen-year awards were presented to **Everett Warner** and **A. L. Sackrey.**

▸ **Walter H. Williams Jr.** has been named to the Oklahoma City, Oklahoma, engineering staff of Tekoil Corporation. He was associated with the Stanolind Oil and Gas Company in Oklahoma and Kansas for 9 years prior to joining Tekoil.

▸ **Dolphe E. Simic** resigned as exploration manager for Frankfort Oil Company. Prior to joining Frankfort, Simic was exploration manager and vice president for Bay Petroleum Corporation for 8 years.

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JENSEN JACK!

It's a well-known fact with producers that a JENSEN JACK is likely to make any oil well more profitable . . . and this goes for yours, too!

A JENSEN JACK is engineered for reliable service and economical operation. Designed with few moving parts — practically never need servicing. One man can change the counterbalance or gear reductions easily and quickly in the field.

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Walton Appointed President of Ideco

Announcement has been made the Ideco Division of Dresser Equipment Company has been reorganized and will be known as Ideco, Inc. Concurrently with this announcement, J. B. O'Connor, president of Dresser Industries, Inc., has also announced the appointment of G. W. "Jack" Walton as president of the new corporation.

G. W. Walton

Since 1954, Walton has been executive vice president of this Dresser subsidiary. Other officers reappointed in the new company in the same capacity as before include W. O. Cook, vice president in charge of engineering and manufacturing; G. G. Wilbur, assistant to the president and vice president in charge of export sales, and F. F. Shiels, vice president in charge of domestic sales.

International Derrick and Equipment Company, incorporated in Ohio in 1920, and a forerunner of the present Ideco, Inc., was the first to make structural steel derricks commercially available to the oil industry. In 1944 Ideco joined Dresser Industries.

Walton, president of this new company, has helped establish manufacturing facilities for Ideco oilfield products throughout Europe—in England, France, Italy and Austria. Widely known both here and abroad as "Jack," he is a native Texan, born in Belton and educated at the Rolla School of Mines where he studied mining engineering.

From a position as superintendent of lead mines Walton entered the petroleum industry 38 years ago as an oil company purchasing agent. He helped to establish the Fort Worth Purchasing Agents Association and was delegate to the first national purchasing agents convention. Walton later served as sales and export representative for various manufacturers of oilfield equipment.

Walton is former president of the Tulsa Chapter of the Nomads, and is a member of the Nomad Board of Regents. Other trade and industrial affiliations include membership in the Petroleum Equipment Suppliers Association, American Petroleum Institute, Independent Producers Association of America, National Association of Manufacturers, American Association of Oilwell Drilling Contractors, Export Club and Petroleum Production Pioneers.

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WHEN PUMPS ARE RUNNING
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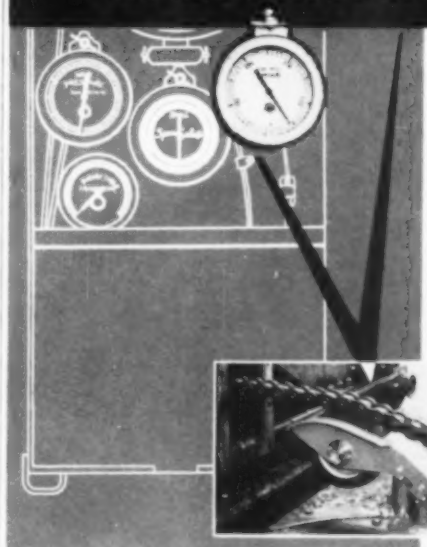
Responds to the slightest torque changes.

Adjustable for net-torque-on-bottom.

WHY MANY OPERATORS DEMAND HYDRO-MECHS ON ALL THEIR RIGS



Easy to move from well to well.

Stabilizes chain and gives it longer life.

Models for single or double-link chains.

The Hydro-Mech idler assembly rides under the rotary chain and transmits hydraulic impulses to a gauge in the drilling-control panel or in any other convenient spot.

Torque is one of the most important variables in any drilling operation — with too little, you're wasting men and equipment; with too much, you're courting an expensive twist-off. Recognizing these pitfalls, more and more contractors and operators are demanding that their rigs be equipped with Hydro-Mech torque gauges. Compared to a $10,000 fishing job, the cost of a Hydro-Mech is certainly negligible.

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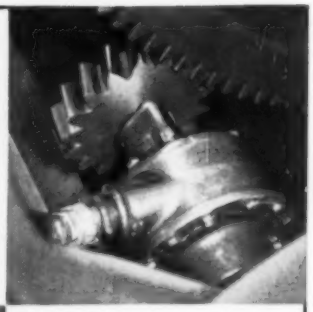

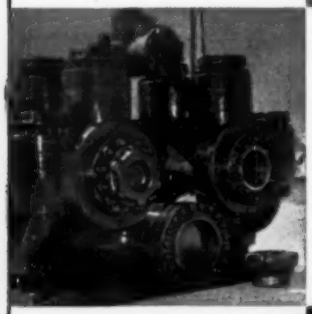

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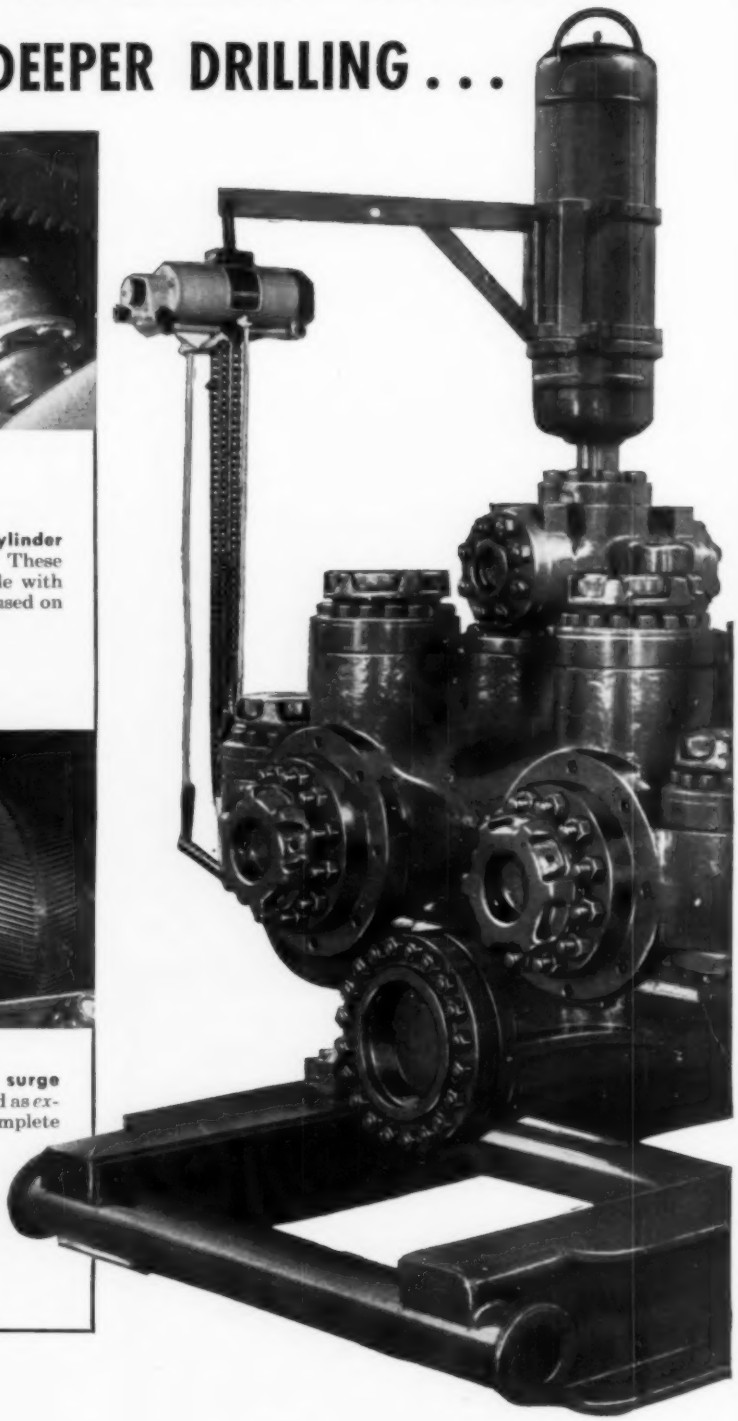
Counterbalanced eccentric. This exclusive GH-GXH feature helps reduce unbalanced forces usually transmitted to the pump foundation or mounting platform.

Newly designed surge chamber. Furnished as *extra equipment*, complete with boom, Keller half-ton hoist, trolley, filter and lubricator, and 8′ air hose. Simplifies handling of heads, valve locks, liners, etc.



Giant 1250 h.p. Mud Pump

TO PROTECT YOUR HUGE WELL INVESTMENTS

This pump is now being manufactured in regular production. Confer with your Gardner-Denver oil field specialist in Dallas, Houston, Corpus Christi, Odessa, Wichita Falls, New Orleans, Shreveport, Oklahoma City, Ellinwood, Casper, Edmonton, Tulsa, Pittsburgh or Los Angeles. Or write Gardner-Denver Company about your mud pumping problems, and for details of the Gardner-Denver GH-GXH 1250 h.p. mud pump.

Gardner-Denver 1250 h.p. mud pump GH-GXH. Liner sizes, 7¾" to 6". Stroke, 18". Deliver from 884 gpm at 2060 psi, using 7¾" liners, to 500 gpm at 3642 psi, with 6" liners.

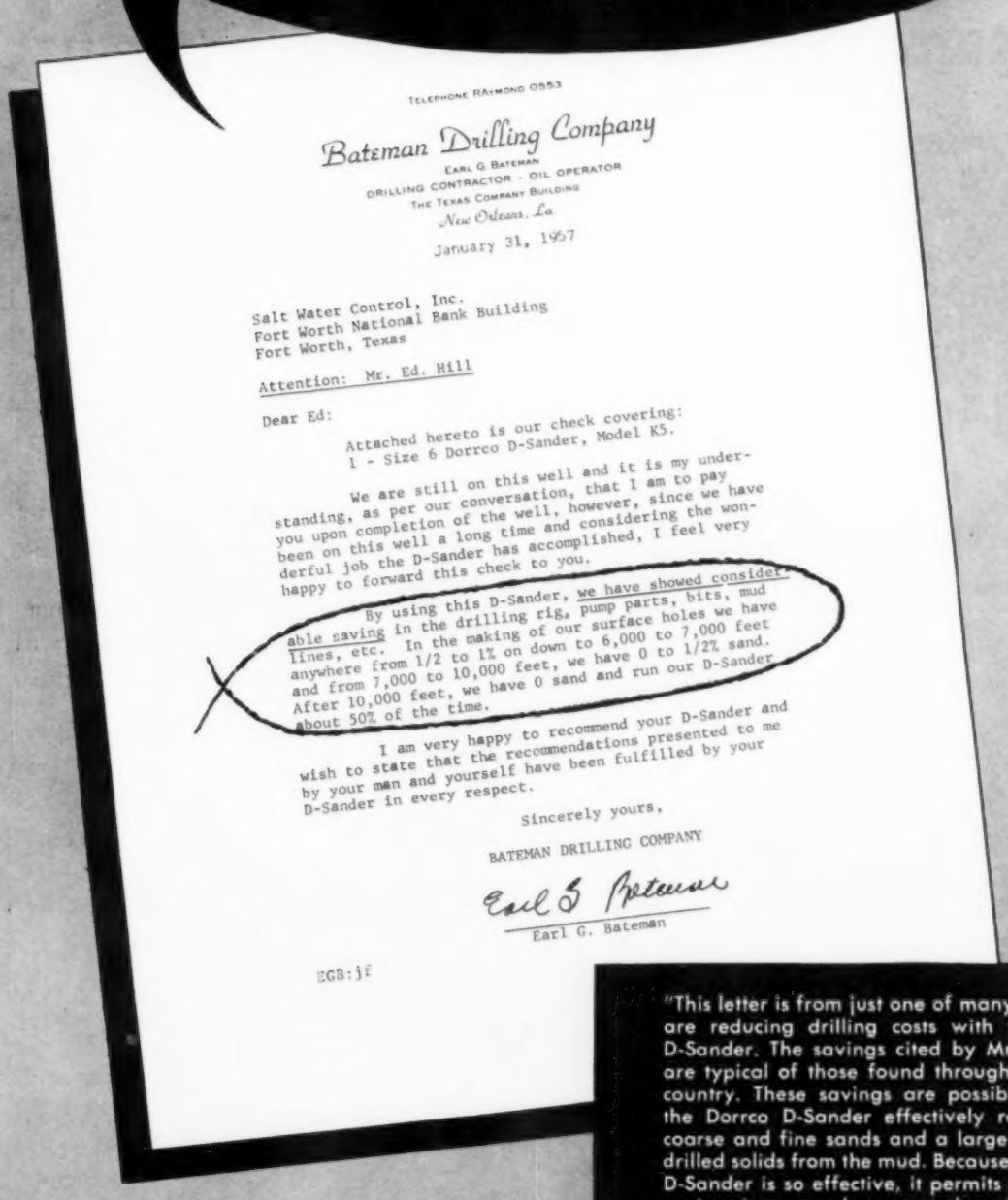
ENGINEERING FORESIGHT—PROVED ON THE JOB
IN CONSTRUCTION, MINING, PETROLEUM AND GENERAL INDUSTRY

GARDNER-DENVER

Gardner-Denver Company, Quincy, Illinois—Gardner-Denver Export Division, 233 Broadway, New York 7, N. Y. In Canada: Gardner-Denver Company (Canada) Ltd., Toronto, Ontario.

Oil Field Offices: Dallas, Houston, Tulsa, St. Louis, Los Angeles, New York, Pittsburgh, Denver, New Orleans, San Francisco, Kansas City, Edmonton, Winnipeg.

"...we have showed considerable saving..."



TELEPHONE RAYMOND 0553

Bateman Drilling Company

EARL G BATEMAN
DRILLING CONTRACTOR - OIL OPERATOR
THE TEXAS COMPANY BUILDING
New Orleans, La

January 31, 1957

Salt Water Control, Inc.
Fort Worth National Bank Building
Fort Worth, Texas

Attention: Mr. Ed. Hill

Dear Ed:

Attached hereto is our check covering:
1 - Size 6 Dorrco D-Sander, Model K5.

We are still on this well and it is my understanding, as per our conversation, that I am to pay you upon completion of the well, however, since we have been on this well a long time and considering the wonderful job the D-Sander has accomplished, I feel very happy to forward this check to you.

By using this D-Sander, we have showed considerable saving in the drilling rig, pump parts, bits, mud lines, etc. In the making of our surface holes we have anywhere from 1/2 to 1% on down to 6,000 to 7,000 feet and from 7,000 to 10,000 feet, we have 0 to 1/2% sand. After 10,000 feet, we have 0 sand and run our D-Sander about 50% of the time.

I am very happy to recommend your D-Sander and wish to state that the recommendations presented to me by your man and yourself have been fulfilled by your D-Sander in every respect.

Sincerely yours,

BATEMAN DRILLING COMPANY

Earl G. Bateman

Earl G. Bateman

EGB:jf

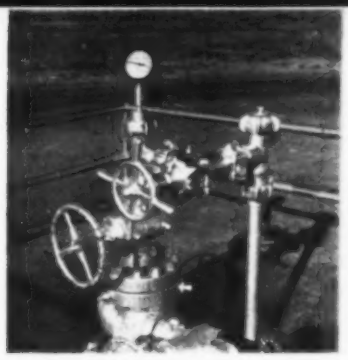
"This letter is from just one of many users that are reducing drilling costs with the Dorrco D-Sander. The savings cited by Mr. Bateman are typical of those found throughout the oil country. These savings are possible because the Dorrco D-Sander effectively removes all coarse and fine sands and a large portion of drilled solids from the mud. Because the Dorrco D-Sander is so effective, it permits substantial savings in areas where normal sand and solids contents were formerly considered low. Contact Salt Water Control for more information and arrange for a trial on your own operations."

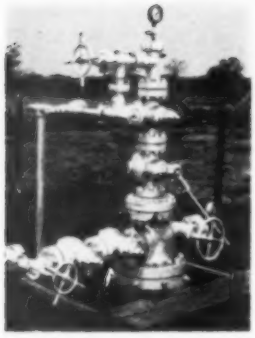
SWACO

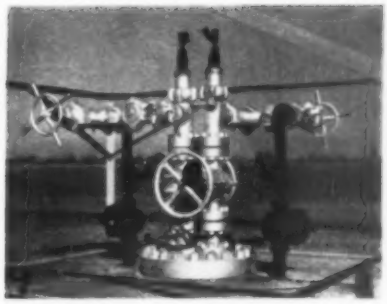
SALT WATER CONTROL Inc.

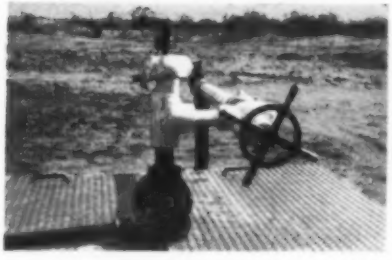
A Sid Richardson Development Company

1211 Ft. Worth National Bank Phone: ED 2-4434 Ft. Worth, Texas









Nice thing about UNIBOLT Flow Manifolds . . .

you buy only what your well needs, and no more

Since well conditions and completion methods differ widely, no one Christmas tree flow control of the "fixed design" type can possibly serve all wells efficiently. Not so with UNIBOLT Flow Manifolds, the components of which may be readily arranged in any design to exactly fit well requirements.

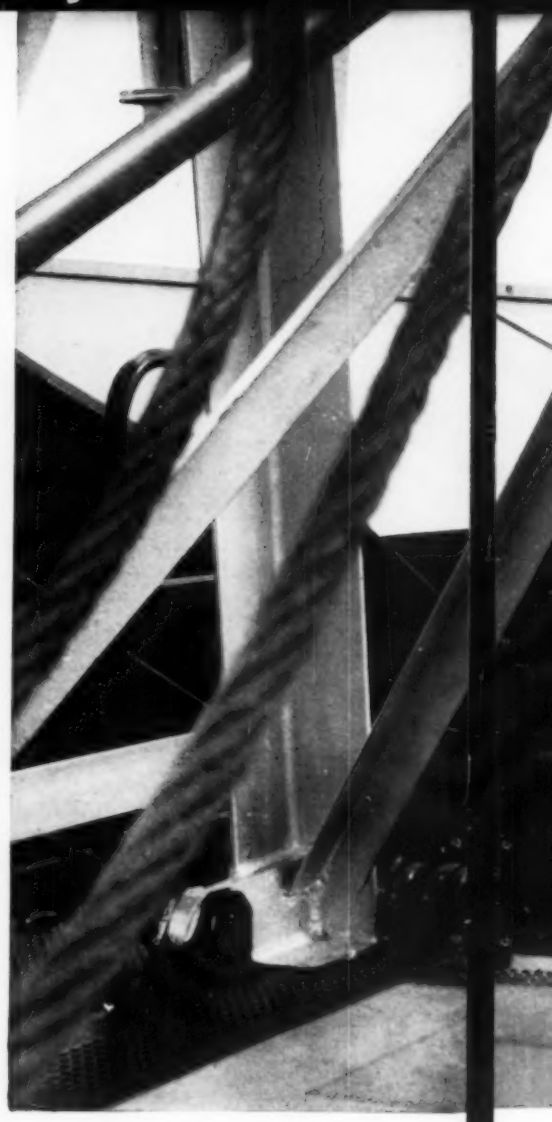
These flexible Flow Manifolds, composed of standard UNIBOLT Tees, Crosses, Adjustable Wing Valves or Chokes, can be combined in a dozen different ways. Thus, you buy exactly what is needed for a given well.

And the entire manifold may be salvaged as a unit or in separate parts for later use in other manifolds.

From the lightest screwed manifold to the heaviest high-pressure assemblies and corrosion-resistant steel, UNIBOLT Flow Manifolds can be tailored to your needs. You save steel and, at the same time, you hold capital investment to a minimum.

THORNHILL CRAVER CO.
P. O. BOX 1184 HOUSTON, TEXAS

Why General Electric Drive Proves Best For Oil Well Drilling Rig Electrification



1 Control simplicity inherent in motor and generator design. General Electric's differential generators eliminate the need for complicated external current and voltage regulating controls, feed-back systems, and torque limiting devices used in some makes of electric drive. Moreover, General Electric's familiar air throttle system eliminates the individual exciters for each generator. The G-E shunt motor will not run away in case of load loss and therefore requires no speed-limiting control devices. This motor has excellent braking characteristics without any added controls. All control provided for the General Electric drive system assures complete regulation of speed and torque simply and efficiently.

2 Can be used with almost any popular oil field engine. A great number of popular oil field engines can be used with General Electric drive including spare engines which you may have in stock. The advantage here is that preference for and familiarity with a particular make of engine need not be sacrificed to gain the benefits of this reliable, efficient, low-maintenance drive system. Parts programs need not be complicated by the addition of a different line. General Electric and the engine builder co-operate so that engine-generator sets are furnished as a completely engineered package. G.E. has two generators available for oil field applications. The GT558R1 generator is a single-bearing, flange-mounted, self-ventilated machine with the following input horsepower ratings: 200 hp at 1200 rpm, 240 hp at 1400 rpm, 280 hp at 1600 rpm, 320 hp at 1800 rpm, 340 hp at 2000 rpm, 350 hp at 2100 rpm. The GE752J generator is a two bearing, single shaft, separately ventilated generator. (It is also available as a two shaft extension machine.) This generator has the following input horsepower ratings: 450 hp at 850 rpm, 550 hp at 900 rpm, 600 hp at 1000-1300 rpm. The GE752H2 motor rates 625 hp continuously and up to 1000 hp for hoisting at 950 rpm.

3 Designed and built by the original manufacturers of electric drive. General Electric is primarily an electrical equipment manufacturer with years of experience in the manufacture of electrical apparatus. The simplicity and flexibility which mark General Electric drive are the result of leadership in the electrical field. The electric drive that will mean so much to your rig operation and to your cost per foot of hole has been pioneered and developed by G.E.

For more information, call your nearest G-E Apparatus Sales Office. (Principal drilling offices in Dallas, Houston, New Orleans, Denver, Tulsa, and Los Angeles.) Locomotive and Car Equipment Department, Erie, Pa. 115-22

PRINCIPAL

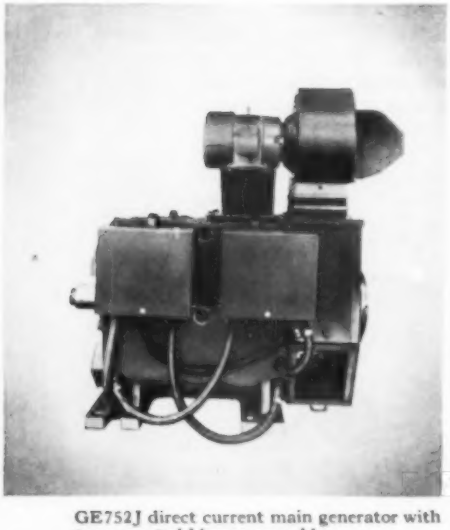
GT558R1 direct current main generator with inspection covers removed.

Progress Is Our Most Important Product

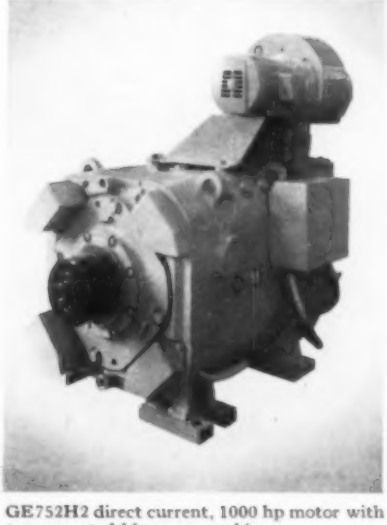
GENERAL ELECTRIC

Operator at drilling controls of General Electric equipped rig built for Shell Oil Company by Ideco, one of the Dresser Industries. Standard air throttles are used for speed controls. These can be incorporated in the draw works console with other air controls, simplifying operation.

GENERAL ELECTRIC DRIVE COMPONENTS:



GE752J direct current main generator with top-mounted blower assembly.

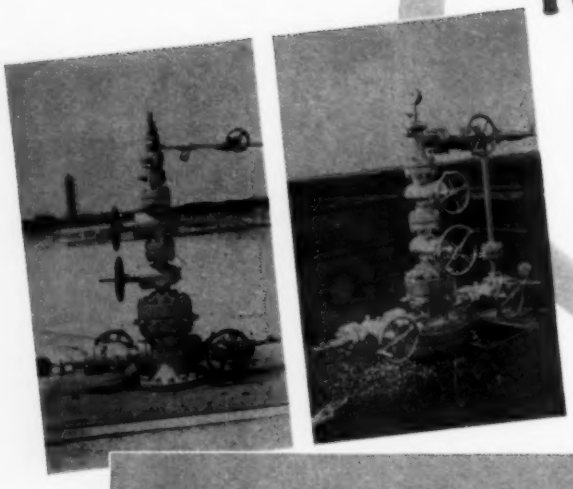


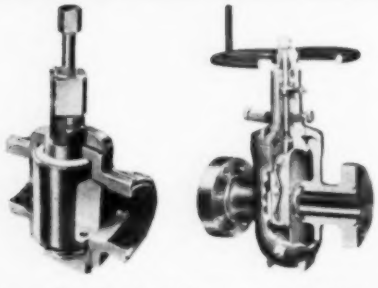
GE752H2 direct current, 1000 hp motor with top-mounted blower assembly.

General Electric control console for use at driller's position.

FROM W-K-M

high PRESSURE and low PRESSURE valves





Here's wide range availability for both high and low pressure services from **W-K-M**.

For safe and positive high pressure control on christmas trees, flow wings, and flow lines, it's **W-K-M** Through-Conduit Gate Valves to handle working pressures from 500 to 15,000 psi.

For "expressway" turbulence-free flow in oil and gas pipelines, it's **W-K-M** ASA Through-Conduit Gate Valves from ASA 300 lbs. to ASA 1500 lbs.

For gathering lines, manifolds, headers and similar low pressure services, it's **acf** Lubricated Plug Valves—200 to 500 lbs. WOG.

You need dependability, performance, minimum maintenance! You need **W-K-M** and **acf** Valves, designed specifically to meet your requirements, in oilfield services, on pipelines, in refineries, in process and chemical plants, and wherever valves are required to control the flow of liquids or gases.

Complete your file of valve information by writing for these **W-K-M** Catalogs. *Address Dept. F-6.*

W-K-M Catalog 200	W-K-M Through-Conduit Gate Valves for oil field services
W-K-M Catalog 300	W-K-M ASA Through-Conduit Gate Valves
W-K-M Catalog 400	ACF Lubricated Plug Valves
W-K-M Catalog 800	ACF Lubricant Manual

W-K-M

DIVISION OF **acf** INDUSTRIES INCORPORATED

PLANT: MISSOURI CITY, TEXAS
MAILING ADDRESS: P. O. BOX 2117, HOUSTON, TEXAS

5703

MANUFACTURERS OF W-K-M GATE VALVES · acf LUBRICATED PLUG VALVES · KEY-KAST ALLOY STEEL PIPING FITTINGS · KEY RETURN BENDS AND FITTINGS

TAKE YOUR CHOICE

got A-1

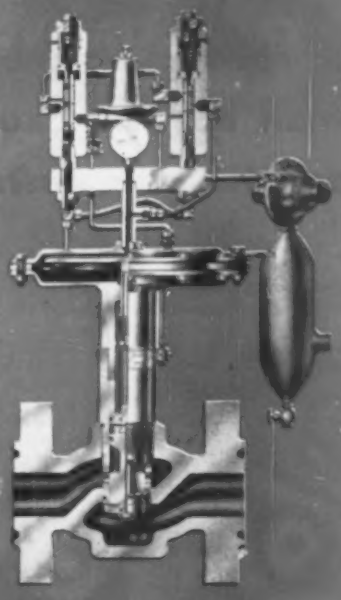
WELLHEAD SAFETY VALVES

either way you're assured of the ultimate in surface protection

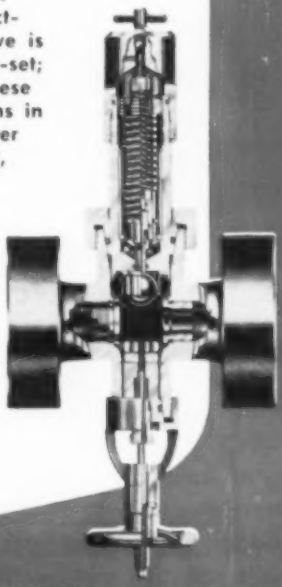
Seldom is one concern able to offer two outstanding and somewhat competitive tools, yet Garrett-A-1 is in that very position. That's why we say 'You make the choice.'

True, there are basic differences between GOT Safety Valves and A-1 Safomatic Valves. The GOT Valve employs power gas from an independent source; the Safomatic is direct-operated by line pressure. The GOT Valve is furnished for manual re-set or automatic re-set; the Safomatic, for manual re-set only. These differences will influence their applications in some instances; however, they do not alter this one fact: Both valves are outstanding, and will perform outstanding service wherever they are used!

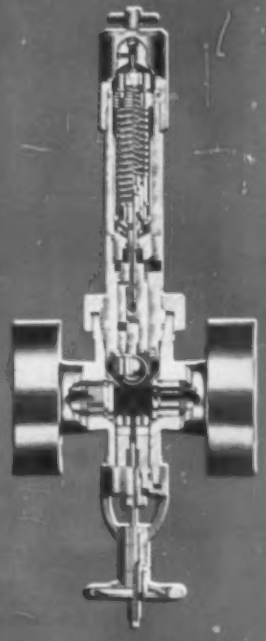
In addition to controlling primary line pressure, both valves are adaptable for control from a remote pressure source, such as a secondary line or vessel. GOT Safety Valves are furnished for working pressures to 10,000 psi; A-1 Safomatics, for working pressures to 15,000 psi. For complete information write to our Longview or Houston offices, or ask your GOT-A-1 representative.



GOT Type "DCB-1" Safety Valve
Includes GOT Type "Y" Controller and Type "DCB-1" Control Valve. Interchangeable pressure elements provide unlimited range of operating pressures. Sizes 2" through 4", connections as specified.



A-1 Safomatic—Standard
Operated by pressure in the line on which it is installed. Furnished in 2" size, only, with screwed, flanged, Graloc and Unibolt connections.



A-1 Safomatic—Remote
Operated by pressure from a remote source. Furnished in 2" size only, with screwed, flanged, Graloc and Unibolt connections.

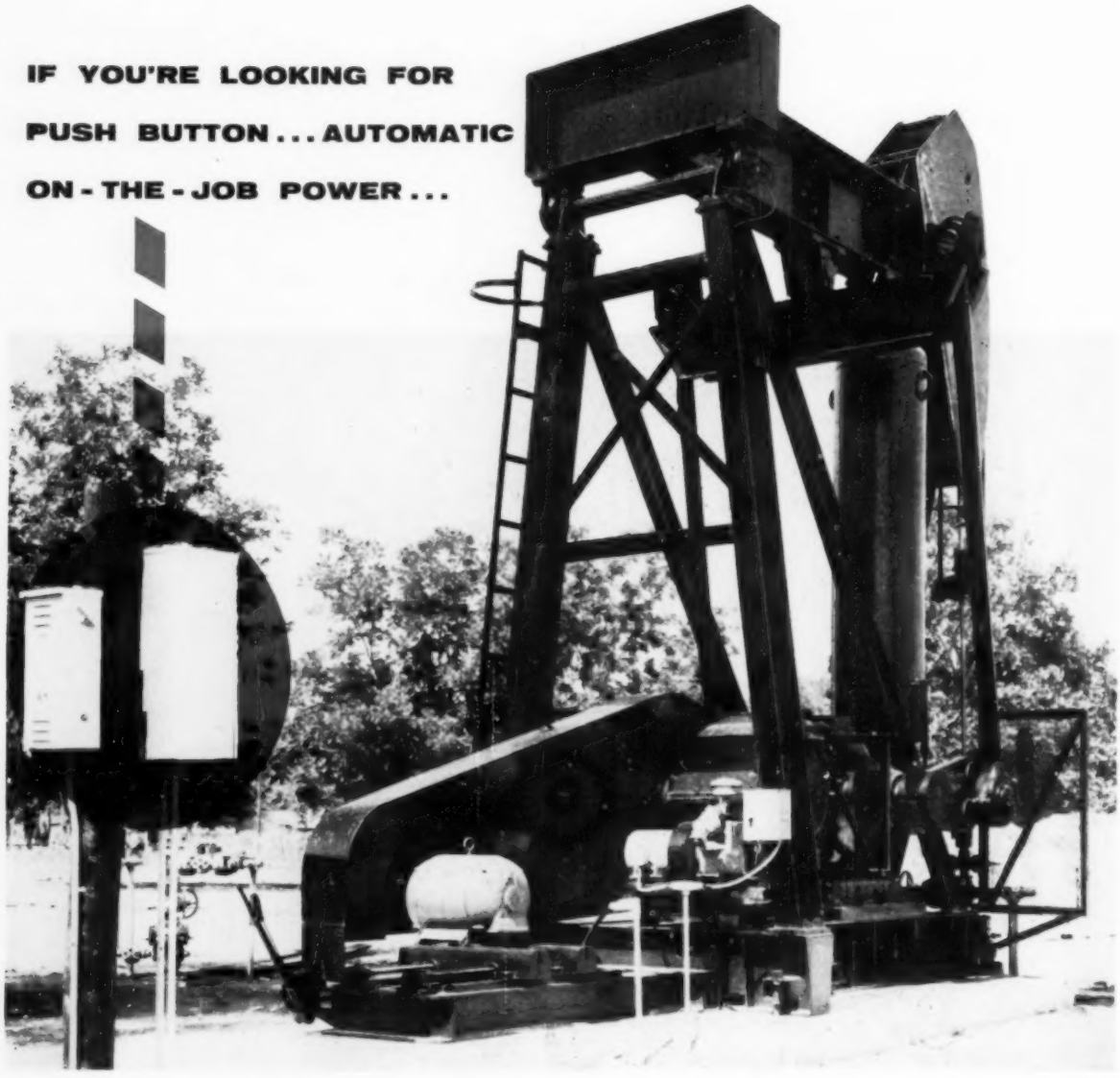
Garrett Oil Tools, Inc.
P. O. BOX 2427 • LONGVIEW, TEXAS
DIVISION OF USI U. S. INDUSTRIES, INC.

A-1 BIT & TOOL COMPANY
Branch of Garrett Oil Tools, Inc.
P. O. Box 2133 Houston, Texas

IF YOU'RE LOOKING FOR

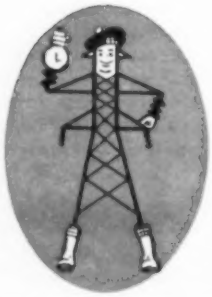
PUSH BUTTON... AUTOMATIC

ON-THE-JOB POWER...



Be a bit shrewder . . . use ELECTRIC POWER

Automation is the key word in more efficient and progressive management today. And when you think of *automation* you must associate it immediately with UTILITY ELECTRIC POWER. Only UTILITY ELECTRIC POWER provides the complete, fully automatic features of automation in oil field production. The evidence is so impressive in favor of UTILITY ELECTRIC POWER that all companies – who consider themselves progressive – will want to know how they can benefit from this modern, efficient power. Call the sales engineer of your Utility Electric Service Company for complete facts.



I'm LCP – Low-Cost Power on the Job 24 Hours Daily

PETROLEUM ELECTRIC POWER ASSOCIATION

P. O. BOX 2771 DALLAS, TEXAS

By Glenn Taliaferro
Johnston Testers

FOR MORE INFORMATION AT THE BOTTOM OF YOUR WELL

FIVE Important Points of D. S. T. Pressure Charts

The science of reservoir engineering is putting greater demand on the field engineer for understanding and interpretative knowledge of Drill Stem Test Pressure Charts. Technical reservoir information can be enhanced by utilizing drill stem test data.

Realizing there is a need for proper evaluation of such data, Johnston Testers is complying by furnishing to the industry a pressure chart combining both "expanded" time and "expanded" pressure. Figures A and B illustrate the same chart, Figure A having the advantage of "expanded" time and "expanded" pressure to aid in the interpretation. By placing Figure A on a *reduced time* scale and removing the *extra inches* of deflection Figure B is produced.

Although Figure A presents a rather complicated appearance, it is simplified by realizing that

1. The chart progresses from right to left and that
2. When a pressure line reaches the left extremity of the chart it will reappear AT THE SAME PRESSURE READING ON THE RIGHT SIDE.

Points of interest on Figure A

1. Initial hydrostatic mud pressure.
2. Initial flowing pressure.
3. Final flowing pressure.
4. Final shut-in pressure.
5. Final hydrostatic mud pressure.

Reading from right to left, the pressure chart indicates the build-up hydrostatic pressure as the testing assembly is lowered in the hole. Upon reaching bottom the initial hydrostatic head of the mud column is recorded in pounds per square inch as indicated at point "1".

With the testing assembly on bottom, weight is applied and the packer is expanded isolating the desired test zone.

After the packer expands, the test tool opens exposing the test zone to the conditions in the drill pipe. This allows the pressure to drop from the initial hydrostatic mud pressure at point "1" to the initial flowing pressure at point "2" and with this decrease of pressure on the test interval, the fluid in the formation is permitted to flow into the well bore.

As the fluid flows from the formation through the perforated anchor and into the drill pipe, the pressure recorders accurately record the increase of pressure from the initial flow pressure at point "2" to the final flow pressure at point "3".

Any changes in pressure during the flow period will be recorded whether they are caused by tool manipulations or formation characteristics and will be easily identified on the flow curve. Examples of these pressure changes during the flowing period could be changing chokes at the surface, partial or complete plugging during the test, operating the equalizing valve to unplug the test tool.

After the well has been flowing for the desired length of time, the shut-in valve in the testing assembly is closed by rotating the pipe to the right. The small volume in the tester assembly from the shut-in valve to the bottom of the hole allows a rapid build-up toward the formation or reservoir pressure and the final shut-in pressure is recorded at point "4".

After the shut-in period is completed the equalizing ports are opened, allowing the mud to flow below the packer, facilitating easy removal of the packer from the packer seat. As the mud equalizes below the packer, the pressure increases to the final hydrostatic mud pressure at point "5" and as the tester is removed from the hole the chart shows the decrease in pressure and returns to the base line as the test tool reaches the surface.

All the pressures measured and recorded are due to the "actions" of various fluids encountered or controlled by the Tester. Mechanical operations, such as sudden changes in running speed, jarring, and so on, will record as vertical lines (pressure) very short time intervals. These lines will not confuse the actual test pressures as they are readily recognized as forces other than those caused by the formation.

For more comprehensive interpretative data write Johnston Testers for the booklet entitled "The Interpretation of Drill Stem Test Data."

FIGURE B

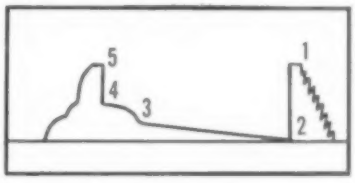
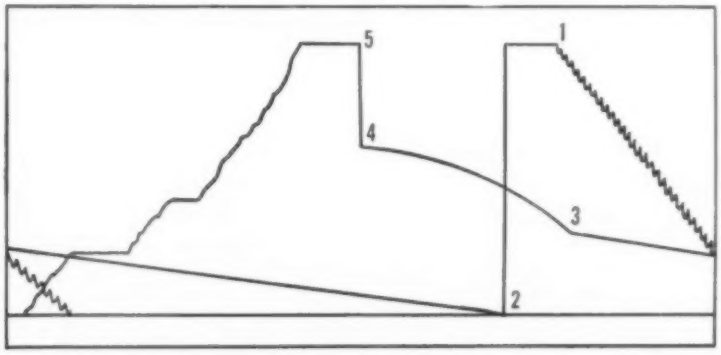


FIGURE A



GLENN TALIAFERRO
Manager of Chart Dept.
Johnston Testers
Houston, Texas

JOHNSTON TESTERS

A Subsidiary of Schlumberger Well Surveying Corporation

first in drill stem testing

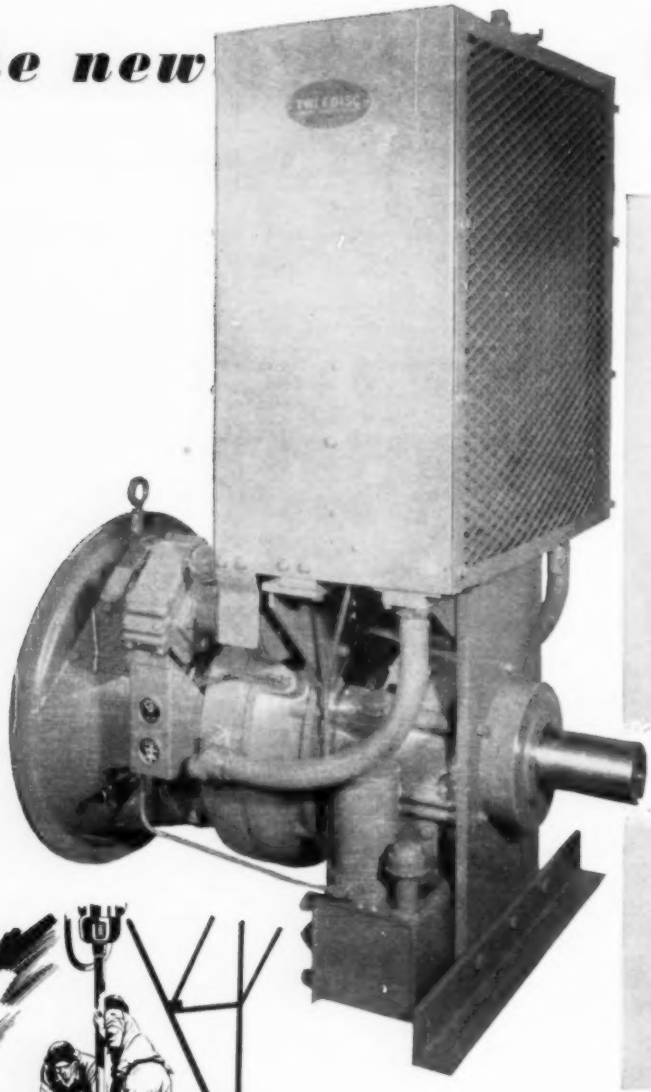
HOUSTON, TEXAS

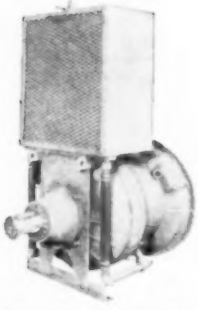
LOS ANGELES, CALIF. CALGARY, CAN.

FORMATION AND CASING TESTING
JOHNSTON

Here's the latest Twin Disc Three-Stage

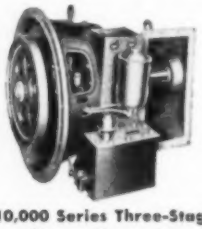
the new HEAVY-





16,000 Series Three-Stage Torque Converter

For engines rated to 1000 hp at 1500 rpm. SAE 00 flywheel housing size or clutch between flywheel and converter.



10,000 Series Three-Stage Torque Converter

From 60 hp at 700 rpm to 335 hp at 2400 rpm. SAE 1 flywheel housing size. Various input-output combinations available.

Further extending its line of three-stage torque converters, Twin Disc Clutch Company now offers the petroleum industry an additional version of its popular 11,500 Series Three-Stage Models.

Designated the Heavy-Duty 11,500 Series Torque Converter (a Standard-Duty version will be continued), the new units have a maximum rating of 586 hp at 2200 rpm. Maximum input torque is 1400 pound-feet. Impellers are available for specific torque ratings of 340, 390, 450 and 540 pound-feet.

Current production units include the Model CF, which provides a clutch at the flywheel, and the Model F, which is connected to the flywheel with a driving ring. Both types are designed for SAE No. 0 flywheel housings.

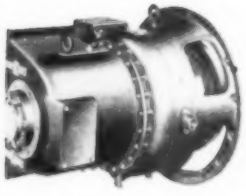
A Twin Disc C-3 Rear End, with the output shaft supported by two heavy-duty roller bearings, is available with either model, permitting maximum output sidepull. Available as optional equipment is a radiator integrally supported as a part of the torque converter.

With the addition of the Heavy-Duty 11,500 Series units, Twin Disc now offers the petroleum industry a line of three-stage torque converters with ideal matching characteristics for engines rated from 60 to 1000 hp and from 700 to 2400 rpm.

The complete line of three-stage torque converters includes five dis-

Torque Converter for oil field applications

DUTY 11,500 *Series!*

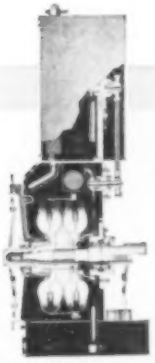


Standard-Duty 11,500 Series Three-Stage Torque Converter

From 60 hp at 700 rpm to 425 hp at 2200 rpm. SAE 0 or 1 flywheel housing sizes. Various input-output combinations.

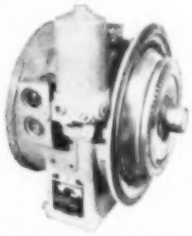
13,800 Series Three-Stage Torque Converter

To 600 hp at 1800 rpm. SAE 00 or 0 flywheel housing sizes. Spider drive or clutch between flywheel and converter.



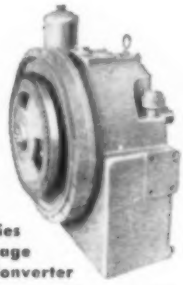
Disconnecting Fluid Power Take-Off

Model 27 for engines to 850 hp at 1525 rpm. Model 21 for engines to 580 hp at 1900 rpm. Radiator and fan standard.



1300 Series Single-Stage Torque Converter

From 30 hp at 1450 rpm to 212 hp at 3200 rpm. SAE 2 flywheel housing size. Output adaptable to SP-111 PTO.



1500 Series Single-Stage Torque Converter

From 30 hp at 1100 rpm to 207 hp at 2500 rpm. With or without clutch. Various input-output combinations available.

Fluid Couplings and HYDRO-SHEAVE® Drives

Fluid couplings from 7.4 to 27 inches, to 850 hp. HYDRO-SHEAVE Drives fractional to 50 hp at nominal motor speeds.

tinct sizes: the 10,000 Series, Standard-Duty 11,500 Series and Heavy-Duty 11,500 Series, 13,800 Series and the 16,000 Series. The line offers 33 specific torque ratings and input and output arrangements to meet virtually every industrial requirement.

These three-stage torque converters have long proved themselves on such applications as drilling rigs, mud pumps and many others. They offer such advantages as multiplying engine input torque (up to 6:1) exactly as required by load . . . cushioning out destructive shocks and vibrations . . . minimizing maintenance and downtime . . . and *producing more work on a hp-cost basis.*

Twin Disc also offers single-stage torque converters rated from 30 to 212 hp at speeds up to 3200 rpm for those installations where milder torque multiplication is desirable.

Twin Disc Fluid Power Take-Offs and Fluid Couplings are available to 850 hp, and are widely used throughout the oil fields where torque multiplication is not required but where the many operating advantages of fluid drive are desirable.

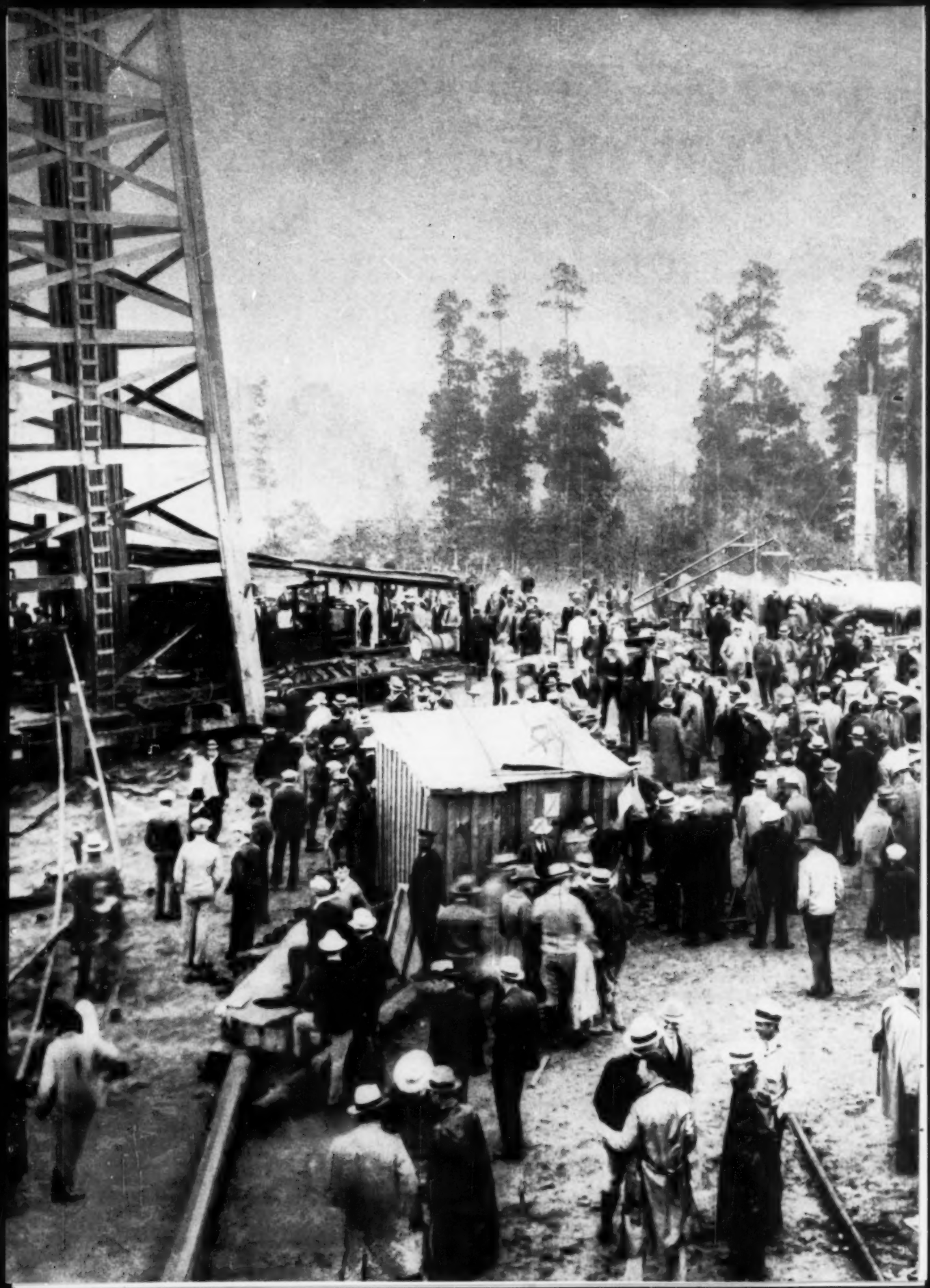
Twin Disc Clutch Company, Racine, Wisconsin; Hydraulic Division, Rockford, Illinois.

TWIN DISC

TWIN DISC

Friction Clutches and Fluid Drives

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



What Makes a Boom?

An oil boom, or any other kind of boom, springs from an idea . . . a good idea.

Patillo Higgins and Captain Anthony Lucas had one and the Spindletop Boom thus was born.

Dad Joiner had an idea and the great East Texas Field became a reality.

Who knows the extent of oil provinces under the seas? Or how much oil will be eventually produced below 30,000 feet? Booms aren't things that live only in history. They're always around. And more are sure to come.

But, booms are more than just ideas . . . they are actions based on careful planning. And, usually they're the result of more than one idea, more than one kind of action.

Take the Christmas Tree, for example . . . it's a part of the first East Texas boom, too—just as it is a vital part of the 1956 oil industry.

About the same time Dad Joiner made his first unsuccessful try in East Texas, O-C-T opened its doors—in an 18 x 20-foot shop in Houston.

By September 3, 1930, the date the famous wildcatter brought in the historic No. 3 Daisy Bradford, the men of O-C-T had followed up an idea with action.

Before the East Texas boom had a good start, they introduced the first factory-assembled, pretested Christmas Tree.

There had been Christmas Trees before, of course.

But these were often slipshod affairs, assembled on the spot with whatever material was available and noted more for their malfunctions than for performance.

O-C-T took the hit and miss out of well control equipment . . . put it on a mass production basis that guaranteed efficiency, economy and availability.

That was the first boom O-C-T participated in, but not the last.

Other ideas, other firsts followed fast.

The company introduced the first 10,000-pound test Christmas Tree . . . the first 15,000-pound test tree . . . the first casing head with an automatic seal . . . the first and only flow control that gives the advantages of both a choke and a valve . . . the first dual tubing string equipment . . . the first 30,000-pound test tree.

Booms aren't things only in history.

They're always around, although not always as spectacular as Spindletop or East Texas.

And more are to come.

Who knows of the oil provinces that lie under seas hundreds of feet deep?

Who knows of the oil provinces buried under 30,000 and 40,000 feet of earth?

There are booms yet to be written of.

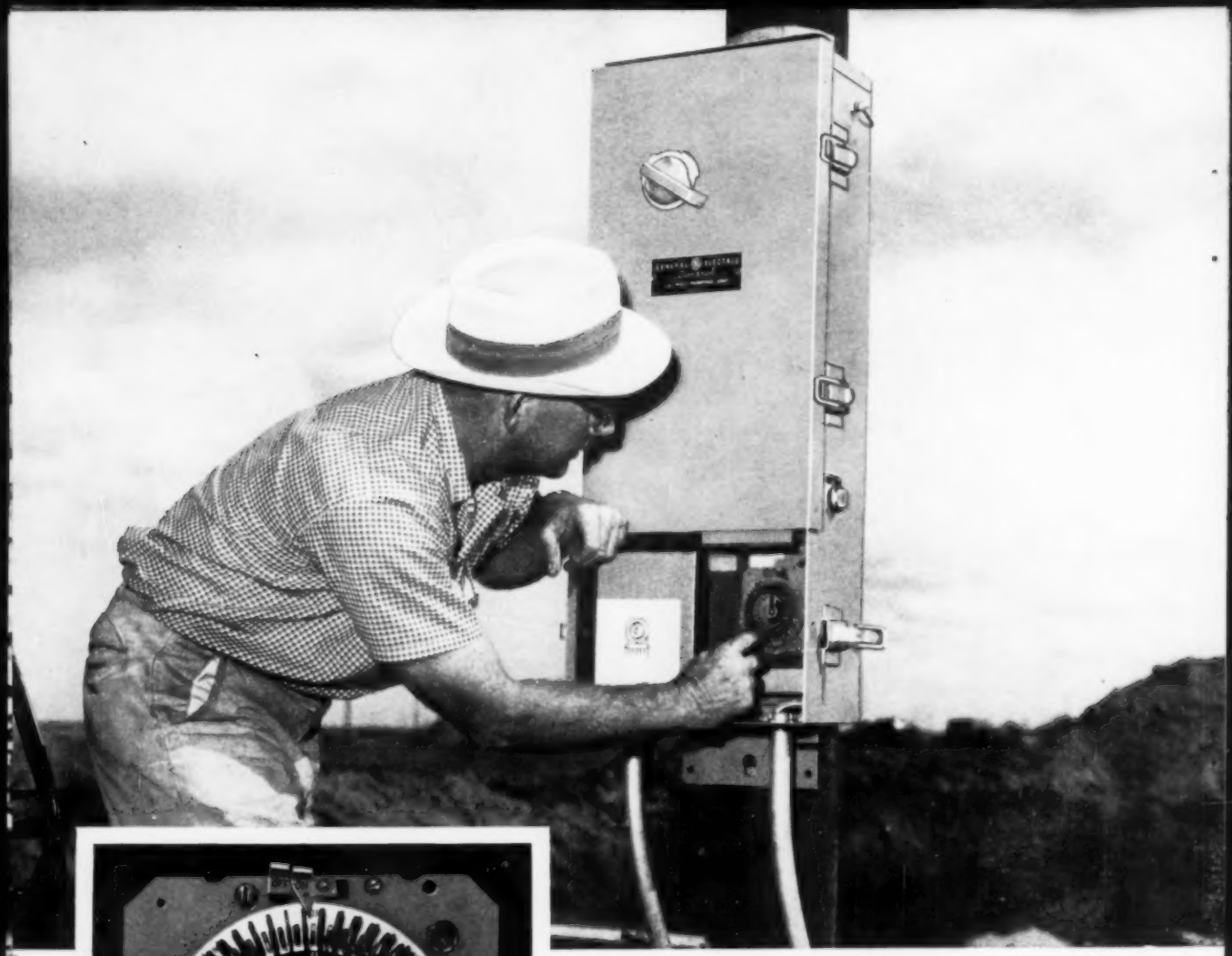
And O-C-T plans to be there with the best equipment in the field . . . not when the booms are history . . . but when they're made.

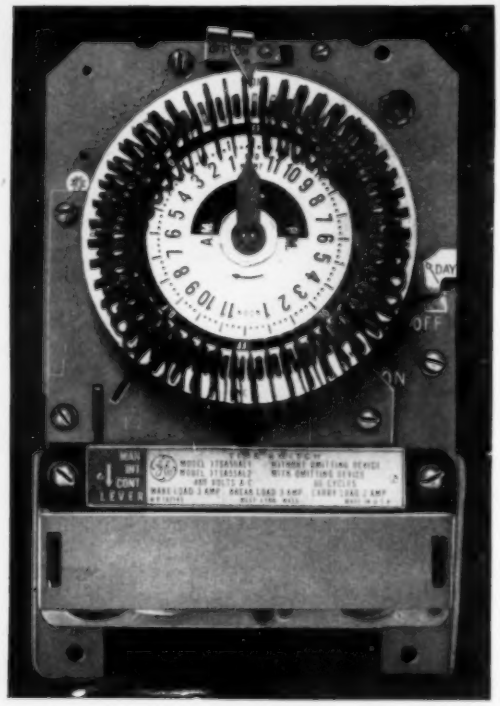
O·C·T

OIL CENTER TOOL CO.

Export Representatives: South America — East West Oiltools, C. A., Del Lago Hotel, Maracaibo, Venezuela. Address Export Inquiries for All Other Countries to P. O. Box 3091, Houston, Texas.

NEVER ANOTHER BOOM like East Texas perhaps, but somewhere around us there are other booms just waiting to be discovered. This is an East Texas scene when oilmen gathered to watch the Lathrop discovery come in near Longview, extending the field 27 miles from the Joiner well. (Photo from "East Texas Oil Field—The First 25 Years," by James A. Clark, courtesy Texas Mid-Continent Oil and Gas Association.





COMBINATION TIMER performs in one device the same functions as a program and a sequence timer.

GENERAL ELECTRIC OFFERS . . .

Easy-to-set program timer on oil-well pumping starters

Setting the pumping cycle is easier with a General Electric oil-well pumping starter. The separate timer door in the G-E enclosure allows changing or setting the timer without opening the main enclosure.

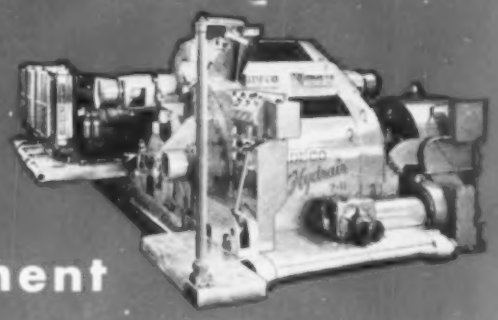
ON-OFF OPERATION is controlled with the G-E combination timer by just flipping the toggle tabs toward or away from the center of the dial. Even with a gloved finger the tabs are easy to set. The full set of tabs program the pumping over 24 hours and in pumping periods as short as 15 minutes. The tabs clearly show the operating time settings.

SEQUENCE RESTART after power failure is provided automatically with the General Electric combination timer. No settings or adjustments of restarting intervals are necessary. Automatic sequence restart helps prevent overloading of the power supply caused by several motors restarting at the same time.

FOR COMPLETE INFORMATION on the G-E oil-well pumping starter, contact your nearest General Electric Apparatus Sales Office or Distributor. Or, write Advertising Section 733-28, General Purpose Control Department, Bloomington, Ill. Ask for bulletin GEA-6410.

GENERAL ELECTRIC

J&L SERVICE
makes IDECO Rigs a blue chip investment



DEPTH RATINGS (FEET) WITH 4½" DRILL PIPE

20,000

16,000

15,000

14,000

12,000

10,500

8,000

7,000

6,000

5,000

4,500

3,300

3,500

RIGS for every job

Get your J&L store on the telephone for information about new IDECO rigs — 2500 Series in electric, torque converter, mechanical, with 2500 HP input.

1350-S AIR-FLO; 1600-2400 HP input; torque converter drive.

PR-1350 AIR-FLO POWER RIG; 1500 HP input; mechanical or fluid coupling drive.

PR-1050 POWER RIG; 1400 HP input; mechanical or fluid coupling drive.

SUPER 7-11; 1250 HP input; torque converter, fluid coupling, or mechanical drive.

H-7-11 HYDRAIR; 700-1050 HP input; torque converter drive.

M-750 mechanical drive; H-750 torque converter drive; 750 HP input.

H-525 HYDRAIR; 600 HP input; torque converter drive.

H-40 HYDRAIR; 400 HP input; torque converter drive; skid mounted, or trailer mounted as a Rambler rig.

H-35 HYDRAIR; 350 HP input; torque converter drive; skid mounted, or trailer mounted as a Rambler rig.

H-30 HYDRAIR; 300 HP input; torque converter drive; skid, truck, or trailer mounted. Servicing depths to 10,000'.

H-25 HYDRAIR; 230 HP input; torque converter drive; skid, truck, or trailer mounted. Servicing depths to 9,000'.

H-20 HYDRAIR; 200 HP input; torque converter drive; skid mounted, or trailer mounted as a Rambler rig. Servicing depths to 7,500'.

PARTS for every rig

An IDECO rig is more than a highly functional piece of rugged equipment.

It's a blue chip investment guaranteed practical by J&L parts service, finest in the United States and Canada.

When you move in with an IDECO, parts are ready. Regularly expendable parts are available at all J&L stores in active drilling areas. Major parts are stocked by J&L stores at these points:

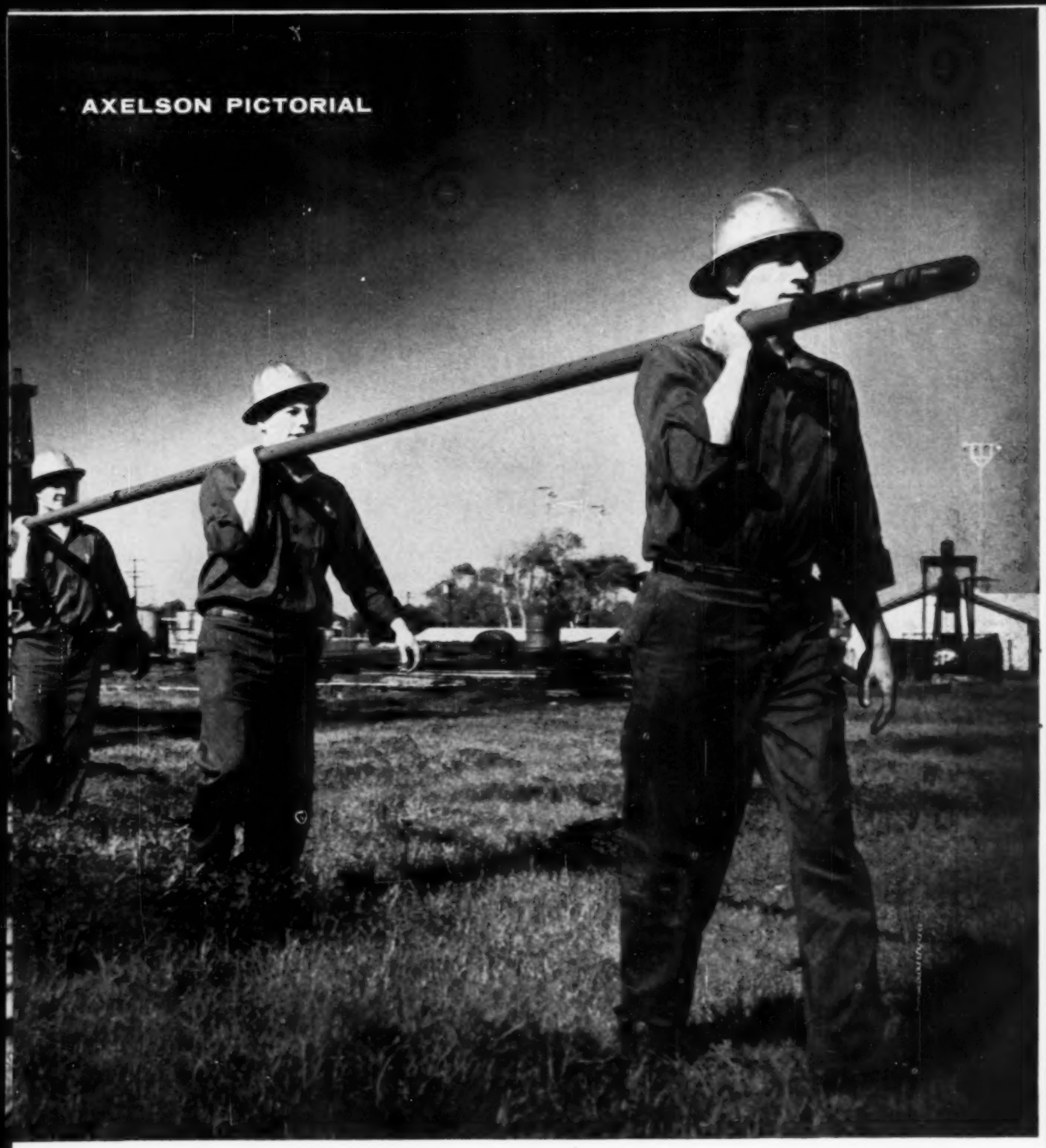
Casper, Wyoming
Great Bend, Kansas
Oklahoma City, Oklahoma
Shreveport, Louisiana
Corpus Christi, Texas
Odessa, Texas
Wichita Falls, Texas
Natchez, Mississippi
Houma, Louisiana
Hobbs, New Mexico
Edmonton, Canada

Jones & Laughlin
SUPPLY DIVISION – Tulsa
SERVING THE UNITED STATES AND CANADA

ALL IDECO RIGS have air controls and air clutches — fast, smooth, flexible. The torque converter on Hydrair hoists provides infinitely variable speed with high torque multiplication. Exactly the power you need is always there without throttling, clutching, declutching. Call any J&L Supply number for IDECO Catalog giving detailed descriptions, specifications, performance characteristics of the world's most wanted rigs.

13-M

AXELSON PICTORIAL



24 FEET OF PUMP is headed for the bottom of a hole, assigned to offset water encroachment by increasing gross production. This Axelson Volumax is constructed as two pumps in tandem, but lifts maximum volumes because its operation simulates two pumps in parallel. As these units reciprocate, two displacement areas simultaneously fill from the formation and transfer fluid into the tubing string.

In addition to stepping up production at the same cycle rate, the Volumax can assure maintenance of current gross production at an appreciably reduced cycle rate.

To overcome the tendency of this pump to unseat, the patented Axelson friction-ring type cup hold-down was developed. Field use of this new type of hold-down has been consistently successful.

150 to 405 MORE BBLS. PER DAY WITHOUT TUBING JOB

Secret of increased production is in filling of entire expanded annular area during upstroke.

Fluid enters here as in conventional stationary pump.

Production men report that expensive tubing jobs are no longer necessary when they want big increases in volume.

Operators in all parts of the country have found they can usually hit their required fluid rate by replacing an insert pump assembly with an Axelson Volumax.

The Volumax is actually two-pumps-in-one with a patented design that allows two displacement areas to simultaneously fill from the formation with each upstroke, instead of the conventional single chamber.

The above diagram shows the extended area that is filled during the upstroke. Velocities of flow are reduced by allowing the larger of the two displacement chambers to fill directly from the standing valve. A lesser quantity of fluid is then required to pass through the restricted seal plunger and pull tube to fill the upper chamber.

On the down-stroke, fluid is compressed, opening the traveling valve and transferring fluid into the tubing.

Ample fluid passages, plus the novel stationary-traveling construction, expedite the entry of fluid from the formation, thereby assuring the maximum fill of the pump during the upstroke.

With any given stroke, a Volumax installed in 2½" tubing allows a 27% displacement increase over a tubing pump. Three applications are pictured at right.

WOULDN'T PUMP DOWN—When the water flood injection rate was increased in Magnolia's Kermit Field, Winkler Co., Texas, the 2¼" tubing liner pump could no longer pump down the well. A VOLUMAX 2½" (2" x 1¼") x 12' x 24' pump was installed, production increased from 360 to 510 bbls./day. Pictured are Axelson's H. E. Summers and Magnolia's C. W. McDonald, assistant production foreman.

HALF OIL, HALF WATER—Richardson Oil's J. E. Hathaway No. 15 in Ward County, Texas, was making 299 bbls. of oil and 302 bbls. of water with a 2¼" tubing pump before a VOLUMAX 2½" (2" x 1¼") x 12' x 24' pump was installed and boosted production to 463 bbls. of oil and 408 bbls. of water/day, with no change in speed or length. Axelson's Summers is with Richardson's B. P. Mathena and J. W. White.

OUTPUT DOUBLED—Axelson service and the VOLUMAX pump again teamed up at Tidewater Oil Company's W. D. Johnson No. 6, also in Ward County, Texas. A 2¼" tubing pump was lifting 430 bbls. total fluid/day with a 54" stroke; this was increased to 835 bbls./day with a VOLUMAX 2½" (2" x 1¼") pump and a 74" stroke. Summers is with O. S. Jones, Sr., a 30-year Tidewater pumper.

AXELSON

AXELSON PUMPS AND RODS

Axelson Manufacturing Company
Division of U.S. Industries, Inc.
6160 South Boyle Avenue
Los Angeles 58, California

For quality production equipment and service:
Axelson stores throughout California.
Jones and Laughlin Supply stores in Mid-Continent, Rocky Mountains, and Canada.
Great Northern Tool and Supply Company in Rocky Mountains.
Dominion Oilfield Supply Company in Canada.
Axelson Dealers and Distributors also located in Mexico, Argentina, Bolivia, Brazil, Colombia, Peru, Venezuela, and Trinidad, B.W.I.

BJ makes old tongs factory new!

Available to you immediately from the BJ tong pool

The longer you keep those old worn-out tongs, the more inefficient and dangerous they become. But don't throw them in the scrap heap, they're worth money to you. You can trade in your old unsafe tongs for a factory-rebuilt pair without losing a single hour of service.

Through Byron Jackson's tong pool, you will receive a set of tongs that have been rebuilt to BJ's original manufacturing specifications. These tongs have been magnetic-particle tested for invisible flaws. Repairs are made with strict adherence to national welding specifications by BJ's factory-trained experts. Modern precision machines, specially designed for tong manufacture and repair, are used. These tongs are re-heat-treated to the same specs as a brand-new tool. Special gauges and test fixtures are used to reproduce the original fits and tolerances.

Don't gamble with makeshift field repairs or welding that weakens the heat-treated strength of your tongs. Play it safe; trade them in for a like-new pair from Byron Jackson's factory-rebuilt tong pool.

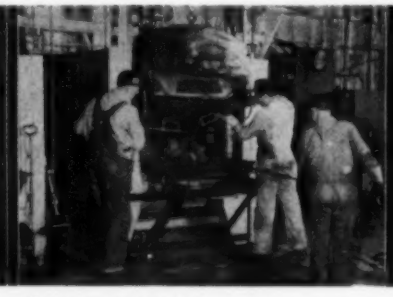
Byron Jackson Tools, Inc.

A Subsidiary of Borg-Warner Corporation

P. O. Box 2017A Terminal Annex, Los Angeles 54, California

WATCH BJ FOR THE NEWEST

All parts are magnetic-particle inspected for hidden flaws before repair is begun.



Tong parts are reheat-treated in electric furnaces to restore their original hardness.

Repaired tools are given final inspection on test stands to determine performance.

NEW Drilling and Producing Equipment

Rotary Table. A new 27½-in. rotary table has been added to Unit Rig's line of equipment. Triple labyrinth mud seal and flinger rings make table mud-proof. Handling lugs are designed with open ends for quick handling. Rectangular lines permit quick and easy flooring buildup.

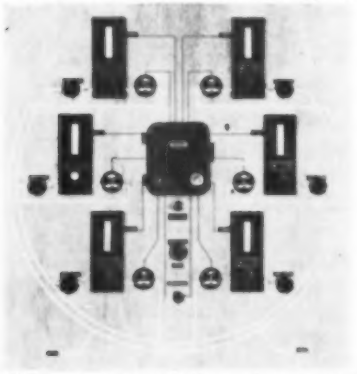
Locking device works on perimeter of table, eliminating all shock loads from gear and pinion. Gears are spiral bevel lapped and matched for smooth performance and hardened to provide long life. Master bushing is locked in place with a single lock operated from top of the table. *Unit Rig and Equipment Company.*

Circle number (1) on reply card.

"Quiet-Line" Silences Interference. Details of a new tone-coded squelch accessory for use with Bendix Dyna-Com mobile communication equipment have been released. The new accessory, trade-named "Quiet-Line," repels unwanted, communication-blocking signals from distant and local stations as well as interfering signals resulting from natural phenomena. Designed to be plugged into the control receptacle of any of the Bendix Dyna-Com line of vehicular communication or base station units . . . without modification, switching feature of the accessory allows the communication system to be operated on either tone-coded or conventional squelch. *Mobile Products Department, Bendix Radio, Division of Bendix Aviation Corporation.*

Circle number (2) on reply card.

Automatic Tank Selector System. Controlling the filling of storage and settling tanks, system uses a pneumatic circuit, with a selector-controller and level transmitters directing operation of pneumatic fill valves. The system is said to be extremely accurate, reliable and economical. In operation, the ATS selector-controller automatically senses the liquid level of each tank in the system through the level transmitter and then automatically opens the fill valve if tank requires



filling, or automatically cycles to next tank if filling is not required. This is the scanning operation which can be continuous or intermittently cycled as needed, requiring only one second per tank. Each ATS circuit can handle up to 12 tanks and 2 or more selectors can be connected in series to control any number of tanks. *Mason-Neilan, division of Worthington Corporation.*

Circle number (3) on reply card.

Threadless Pipe Fittings. Fittings will withstand traction forces up to 3600 lb and hydro-static pressures ranging from 450 psi on 2-in. pipe to 5000 psi on ½-in. pipe. Superior gripping action is achieved through a specially designed brass clutch ring with internal serrations which grip the pipe wall as the fitting nut is tightened. At the same time, a Neoprene gasket is compressed against the pipe wall. Thus, a permanent seal against leakage of gas or liquid, and resistance to abnormal vibration, contraction or expansion is achieved. *Telsco Fittings Division.*

Circle number (4) on reply card.

BJ Announces 500-Ton Hook. A new 500-ton capacity hook is being manufactured for the petroleum industry. The "5500" is a rugged, streamlined giant created to safely hold the long string of pipe and casing needed for the deepest drilling operations — both offshore and onshore. Among the more important features stressed is the BJ hook positioner, which can be preset to automatically turn the elevator door handles so they face the derrickman when the elevator reaches the monkey board. The "5500" also has the hydraulic snubber, which prevents drill pipe bounce, battered joints, and high maintenance. *Byron Jackson Tools, Inc., a Borg-Warner subsidiary.*

Circle number (5) on reply card.

Oil Well Pumping Control. A new line of pumping controls for oil wells has been designed to provide automatic control for timed cycle pumping operations. New devices weigh under 100 lb, emphasizing compact construction and versatility. Mechanism incorporates Federal Pacific's 504 across-the-line magnetic starter in sizes 1, 2, or 3, protected by 3 overload relays. All units are equipped with a 3 position auto-hand-off selector switch, while disconnecting means and short circuit safety for starter, motor and load side wiring are provided by a Type A heavy-duty, front-operated fusible switch. Restarting automatically resets the undervoltage relay. *Federal Pacific Electric.*

Circle number (6) on reply card.

Gas Measuring Instrument. The Atlas "Chart-O-Gas" gas measurement and recording instrument, Model 550, again is being produced and marketed. This unit has not been offered by the company for several years. Gas emerging from the wellhead during drilling is recorded by the "Chart-O-Gas" instrument and the actual percentage of the lower explosive limit is measured and continuously recorded on a chart which becomes a permanent record. A classification instrument is part of the panel and is used with a sensing unit to measure the methane or the propane and butane series in cuttings and cores. *Atlas Laboratories, Incorporated.*

Circle number (7) on reply card.

Oil Well Pumps. A new series of oil well pumps designed for wells producing from 250 to 600 bbl per day has been announced. The new "450" series includes pumps from 7½ to 20 hp for well casings of 5½ in. or larger. New pumps will lift fluids from depths of 900 to 4400 ft, with fully automatic operation available. Models of the new pumps are available for operation from 440, 762 or 880-v power sources. *Reda Pump Company.*

Circle number (8) on reply card.

Radiotelephone for Field Work. A new portable AM radiotelephone developed to handle field communications has been developed. Designated the TR 246 Packset, it is designed to provide reliable field communications in areas where terrain features make the use of VHF equipment impractical. The Packset assures long battery life through the use of low drain tubes. Special features include built-in metering facilities, receiver noise limiter, and squelch system. Packset has a telescoping 16-ft antenna and weighs 23 lb. *Kaar Engineering Corp.*

Circle number (9) on reply card.

Weatherproof Recording Gages. Recording gages for pressure, vacuum, and water or liquid level measurements are now available in new weatherproof cases. Gages are designed for wall or pole mounting outdoors, where they will be subjected to all types of weather. Measurements of water depths or other liquids can be accomplished with float-type, pressure-type, differential-pressure-type, or bubbler-type liquid level gages; pressure gages are offered in all ranges. *The Bristol Company.*

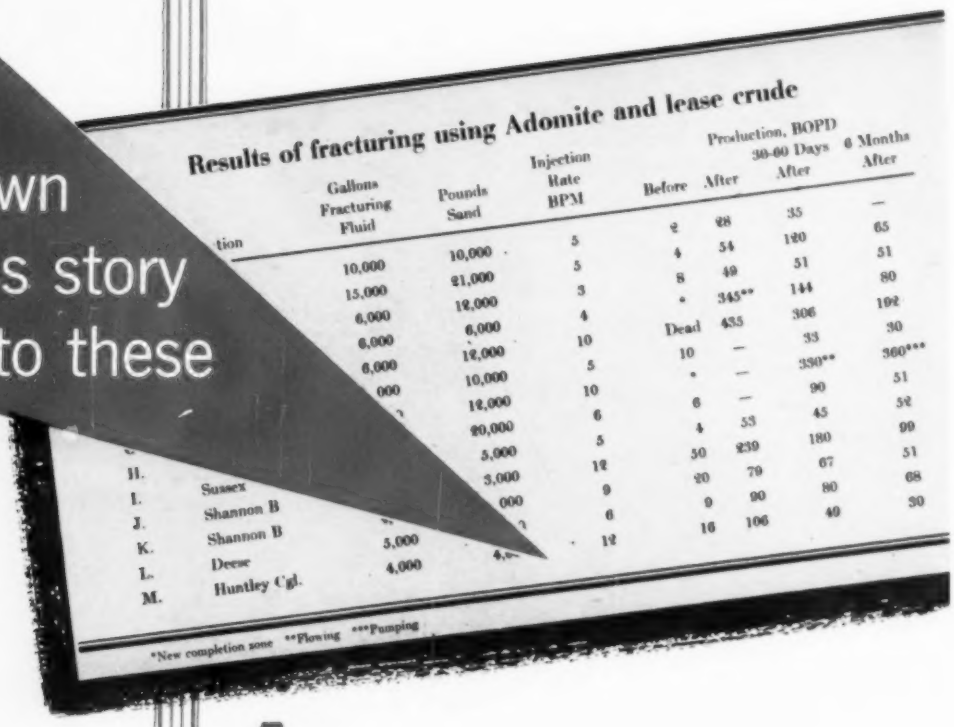
(Circle number (10) on reply card.

Automatic "Dial-Direct" Radiotelephone. An automatic "dial-direct" mobile 2-way radiotelephone system has been made available. The system allows phone calls to-and-from vehicles to be relayed, completely unattended, through local telephone systems. Reduced costs to the user, because of the automatic features, greatly expand the potential application of such equipment. Unlike other radiotelephone systems, it operates on a 24 hour basis and no manual operators are

required. Calls are made from a vehicle by simply dialing a number within a local telephone system; also, anyone within that system can call the vehicle in the same manner as when making a house-to-house call. Only when placing a toll call must the long distance operator be contacted. *Allen B. Du Mont Laboratories, Inc.*

Circle number (11) on reply card.

Add your own success story to these



Results of fracturing using Adomite and lease crude

		Gallons Fracturing Fluid	Pounds Sand	Injection Rate BPM	Production, BOPD Before	After	30-60 Days After	6 Months After
	tion	10,000	10,000	5	2	28	35	—
		15,000	21,000	5	4	54	120	65
		6,000	12,000	3	8	49	51	51
		6,000	6,000	4	*	345**	144	80
		6,000	12,000	10	Dead	435	306	192
		000	10,000	5	10	—	33	30
			12,000	10	*	—	330**	360***
			20,000	6	6	—	90	51
			5,000	5	4	33	45	58
H.			3,000	12	50	239	180	99
I.	Sussex		000	9	20	79	67	51
J.	Shannon B			6	9	90	80	68
K.	Shannon B	5,000		12	16	106	40	30
L.	Deese	4,000						
M.	Huntley Cgl.							

*New completion zone **Flowing ***Pumping

fracture with Adomite

Adomite®—and only Adomite does so many things so effectively

Seals the fracture face . . . minimizes fluid loss . . . no damage to formation.

Longer fractures . . . deeper penetration of sands.

Fewer sandouts . . . reduces fluid loss in rock matrix, prevents buildup of sand concentrations in the fractures.

Saves you money . . . utilizes your own lease crudes . . . saves transportation costs.

Decreases friction loss . . . low viscosity of Adomite-created fracturing fluid permits use of less pumping equipment than with viscous refinery residuals.

Reduces hazard of emulsions . . . emulsion-breaking characteristics are important consideration to many producers.

Adaptable to virtually all types of crude, Adomite is all you need to control fluid loss of kerosene, crudes, gelled crudes or refinery residuals.

Producers who say Adomite . . . stay with Adomite.

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Get greater profits from your next fracturing job—

TELL YOUR SERVICE COMPANY TO USE Adomite

What you need here is an ALDRICH PUMP

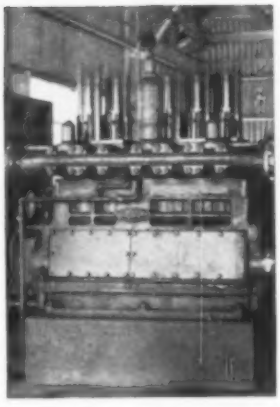
Where pumping operations demand *complete reliability*, Aldrich Pumps assure it—along with unusual freedom from maintenance.

Dependable service. Continuous, heavy duty pumping—at high pressures—is routine with Aldrich Pumps. Aldrich gives dependable low-cost performance in waterflooding, pipe line, gasoline plant, hydrocarbon, injection and petrochemical services. The simplicity of the Aldrich Direct Flow design and the reduced space between valves result in higher volumetric efficiency.

Low-cost maintenance. Fluid end sectionalization, with changeable plunger sizes and interchangeability of parts, means long life and fast, easy maintenance. Parts can be replaced easily and quickly, at low cost. Valves can be removed for inspection or replacement without special tools or equipment. Individual sections of the fluid end can be replaced at a fraction of the cost of conventional type fluid ends.

Get full details. Write for your copy of Data Sheet 100, a condensed catalog and selection table covering our entire line. The Aldrich Pump Company, 26 Pine Street, Allentown, Pa.

Field parts stock available in Carmi, Ill., Charleston, W. Va., Houston, Los Angeles, Odessa, and Tulsa.



Two Aldrich 3½" x 5" Direct Flow Pumps on lean oil service. Aldrich Direct Flow units are available in 2½", 3", 5" and 6" stroke sizes with 3, 5, 7 or 9 plungers. Sizes range from 25 to 2400 hp.

THE ALDRICH PUMP COMPANY

NEW Literature

For more information on items described here in brief, use the handy reply card and circle the corresponding numbers

Perforated Metals. A new 4-page folder describing Wissco perforated metals for ornamental and industrial purposes has been made available. Folder gives complete ordering specifications for Wissco metals which are available in various patterns including cane, lattice, slat and standard round perforations. Actual-size photographs of the various types of Wissco perforated metal, as well as specifications for maximum sheet widths, percentage of free air opening, and cost per available gages are included. *Wickwire Spencer Steel Division of The Colorado Fuel and Iron Corporation.*

Circle number (24) on reply card.

Bowen-ITCO Catalog. A 76-page catalog covering the oilfield specialty tools manufactured by Bowen-ITCO is now available. Included are sectional airbrush drawings for blowout preventers, jars, overshots, wire line equipment, spears, weight indicators, and wellhead assembly components, as well as complete information on use, operation, assembly, and maintenance. Complete parts and price lists are also included. *Bowen-ITCO.*

Circle number (25) on reply card.

Zyglo and Zyglo-Pentrex. New booklet includes complete information on fluorescent penetrant materials and fluorescent penetrant testing. It makes clear the best selection of fluorescent penetrant materials and techniques for any individual testing use. Because Zyglo and Zyglo-Pentrex are widely used wherever non-magnetic materials are manufactured or tested during overhaul, this booklet should be helpful in selecting and controlling the best test for each usage, and in selection of the test which will be the most economical in use, consistent with the requirements of the test to be performed. Booklet also contains a first in the use of the new fluorescent offset printing inks to represent the fluorescent indications of defects shown by Zyglo and Zyglo-Pentrex. Fluorescent indications have extreme advantages in speed and sensitivity when testing under Black Light *Magnaflux Corporation.*

Circle number (26) on reply card.

Trouble Shooting. If you are having trouble with a specific piece of equipment, what do you do? A bulletin released by Cummins Engine recommends that first you think before you act. Then ask yourself these questions: (1) What were the warning signs preceding the trouble? (2) What previous repair and maintenance work has been done? (3) Has similar trouble occurred before? The bulletin is entitled "Principles of Trouble Shooting for Cummins Diesels." It is designed to unfold so that it can be used as a wall chart. On the chart complaints are listed and probable causes are noted. Trouble shooting, according to the bulletin, is nothing more than an organized study of the problem and a planned method of procedure for the investigation and correction of the difficulty. The chart includes some of the most common complaints that may be encountered during the service life of a diesel engine. *Service Division of Cummins Engine Company, Inc.*

Circle number (27) on reply card.

Revised Catalog. Anderson's 1957 catalog itemizes principal applications of its purifiers. New information has been included on improved types of internal purifiers for installation inside evaporators, boilers and other process vessels. Buying information is given on line type purifiers for installation as a compact unit on pipelines and receiver type scrubbers for handling extremely large slugs of liquid. A selection chart shows recommended sizes of line type Hi-eF purifiers at various steam flows on different pressures. Another new feature of the catalog is a section on new Quik-Flex thermostatic steam traps which are guaranteed freeze-proof on all petroleum and chemical applications. Anderson Super-Silvertop steam traps, Heat-Quik float traps and self-cleaning strainers are also cataloged. *The V. D. Anderson Company, division of International Basic Economy Corporation.*

Circle number (28) on reply card.

Pressure-Stress Ratios. A 27-page booklet has been published on pressure-stress ratios for determining allowable working pressures. It lists the Barlow formula, the Modified Lame formula, the Average Diameter formula, and the Creek formula, with tables giving the precalculated values for each pipe size and weight based on a wall thickness of 87½ percent of nominal and for values of C varying from 0.0 to .100 in. in steps of .005 in. By means of one simple arithmetical operation of multiplication or division, P/S ratios may be used to readily determine allowable working pressure, working stress, and wall thickness required. *Tube Turns, a division of National Cylinder Gas Company.*

Circle number (29) on reply card.

New Fracturing Additive. A bulletin has been published explaining Gypban, a new, gyp-retarding, sequestering agent. Gypban offers new, prolonged protection against formation-plugging gyp. In the form of granular material, it is a complex phosphate sequestering agent that is oil insoluble, and dissolves only very slowly in water. Application is in conjunction with a fracture treatment. Bulletin explains how Gypban is mixed into the fracturing fluid with the sand just prior to injection. It also lists results from field treatments. *Dowell Incorporated.*

Circle number (30) on reply card.

Indirect Heater. A 24-page technical booklet describing a new indirect heater has been published. Included is a detailed description of the equipment, illustrated with cut-away photographs and drawings. A section in the book gives detailed instructions on how to solve specific heating problems on the lease. Charts giving engineering data necessary to the solution of these problems are included. Catalog number is Ih-4-57. *The Parkersburg Rig and Reel Company.*

Circle number (31) on reply card.

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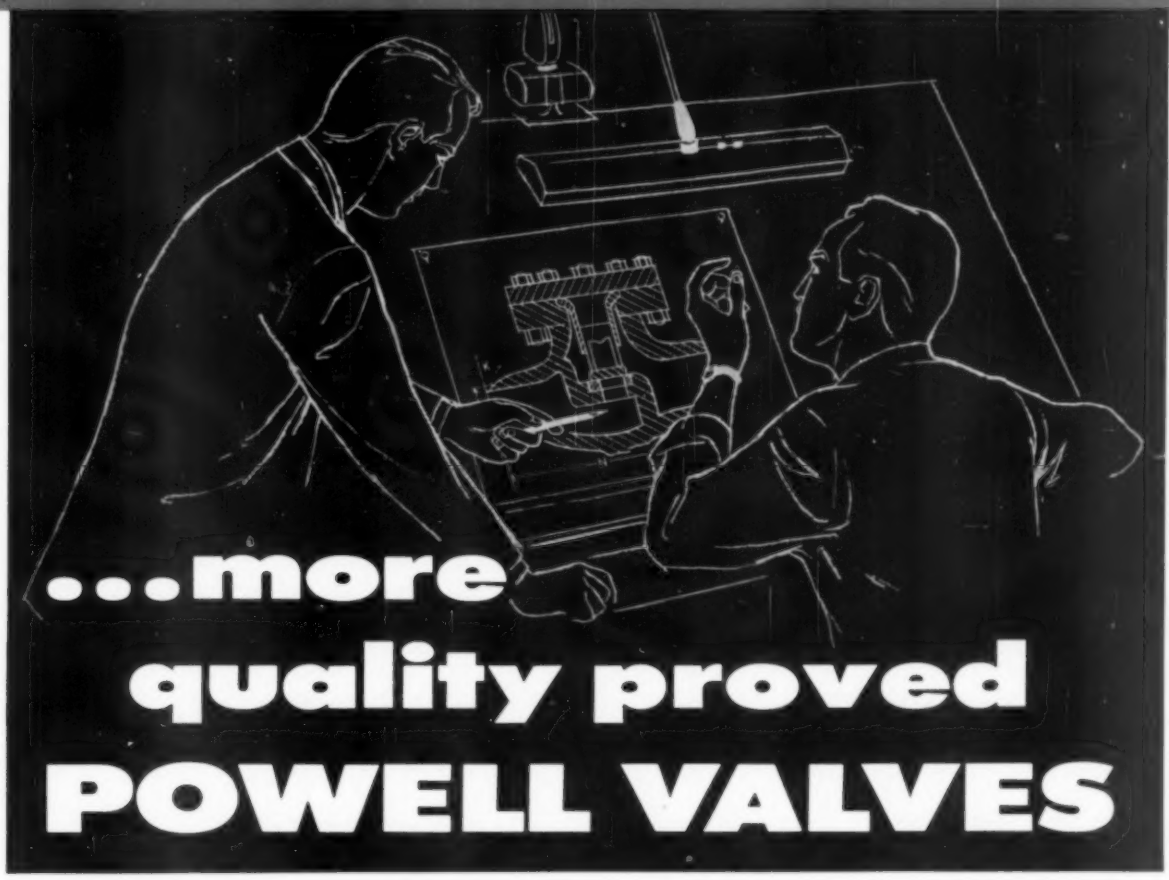

...more quality proved POWELL VALVES

FIG. 3003—Steel Gate Valve for 300 Pounds W.S.P.

FIG. 1559—Steel Lubricated Plug Valve, ASA 150 Pounds, Screwed Gland Type, 1" to 4", inclusive.

FIG. 2456 SG—Large Stainless Steel Gate Valve for 150 Pounds W.P. Flanges conform to latest Standards.

FIG. 6061—600-Pound Steel Swing Check Valve.

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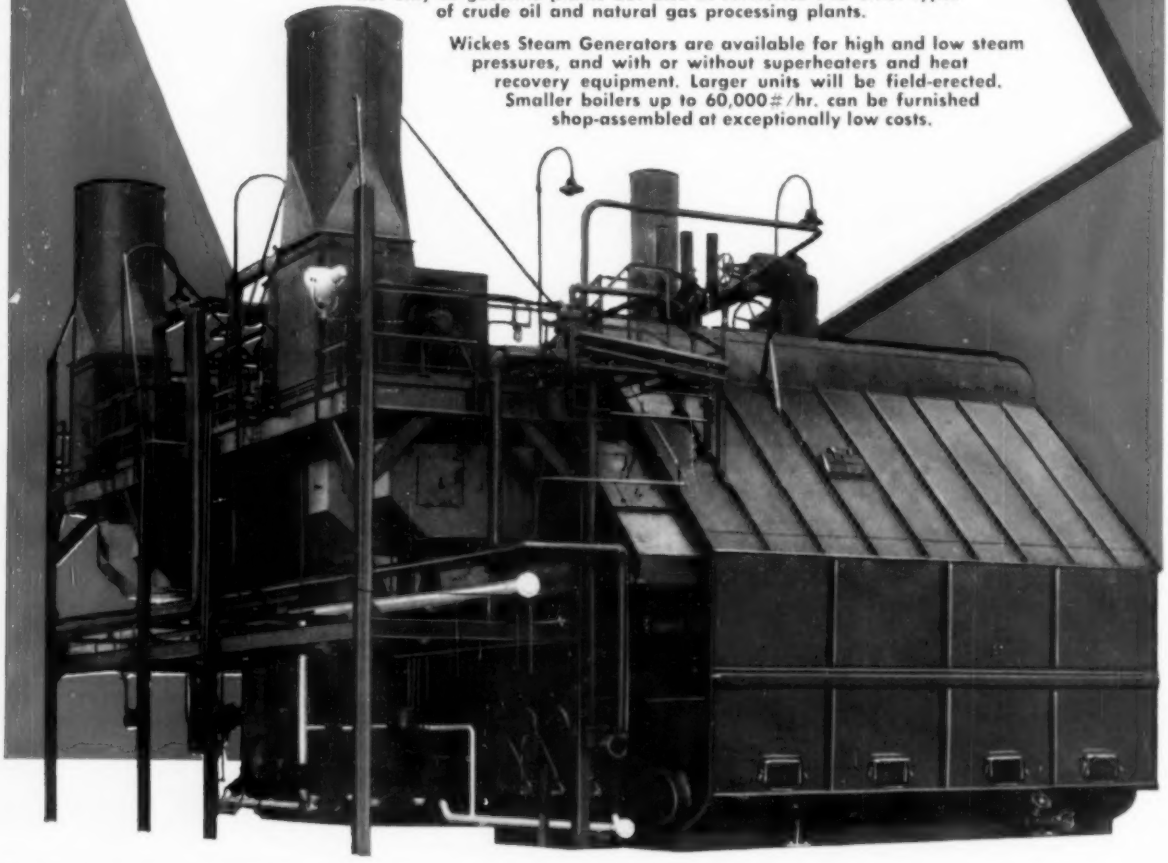
money making
Wickes steam generators

The two Wickes A-Type Steam Generators shown here are installed in a large natural gas treating plant in the Southwest. They are field-erected and designed for outdoor operation under any weather condition. These units have been in continuous operation since 1949 and have demonstrated that Wickes Boilers can be relied upon as a dependable, economical source of steam, so vitally important in this type of plant

Wickes Steam Generators are finding ever increasing acceptance, not only in gasoline plants but also in refineries and other types of crude oil and natural gas processing plants.

Wickes Steam Generators are available for high and low steam pressures, and with or without superheaters and heat recovery equipment. Larger units will be field-erected. Smaller boilers up to 60,000#/hr. can be furnished shop-assembled at exceptionally low costs.



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DIVISION OF THE WICKES CORPORATION
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New Projects in refining gas processing petrochemicals

Chemoil Corporation expects to start construction of a 30,000 BPD refinery midway between Baton Rouge and New Orleans within the year. Process units will include catalytic cracking, reforming, alkylation, coking, and polymerization plants. In addition to fuel products, the refinery will make petrochemical raw materials such as ethylene, propylene, and other LP-gases.

Sinclair Oil and Gas Company has installed a 12 MMcf/D gas dehydration unit, is building a 1100-hp compressor to boost absorber residue gas from 160 to 1000 psi in order to expand the capacity of its gas products plant near Taft, Texas.

Spencer Chemical Company will double polyethylene capacity at its Orange, Texas, plant to total capacity of 90-million lb per year.

Shamrock Oil & Gas Corporation is building a 2000 BPD butane isomerization plant and a Phillips thermal cracking unit to make about 1500 BPD of B-B alkylate feedstock. Being built at Shamrock's 16,500 BPD refinery near Dumas, Texas, most of the butane will be supplied by their adjacent natural gasoline plant.

Shell Oil Company is constructing a 12,000 BPD Platformer at its Norco, Louisiana, refinery, scheduled for operation by the summer of 1958. Feed hydrodesulfurization will be included.

Food Machinery and Chemical Corporation is modernizing and doubling the capacity of its carbon tetrachloride plant at South Charleston, West Virginia. Fluor Corporation is doing the work, expects to finish the project in early 1958.

Humble Oil & Refining Company is adding a 2,770,000 cu ft per day diethanolamine gas purification unit at the Baytown, Texas, refinery. Including three purification trains, the unit is designed by Girdler Corporation and will be built by M. W. Kellogg.

Davison Chemical Company will manufacture polyolefin catalyst, under license from Phillips Petroleum Company. A unit rated at 8000 lb per day initial capacity will be built at Davison's Cincinnati, Ohio, plant.

Phillips Petroleum Company plans two new catalytic reformers, a 3700 BPD unit at Woods Cross, Utah, to be built by Procon, Inc., and a 16,000 BPD unit at Sweeny, Texas, to be constructed by Fluor Corporation. Both are scheduled for completion in spring, 1958.

A reactor weighing 83 tons is eased into place at Gulf Oil Corporation's Port Arthur, Texas, propylene polymer plant, by Procon Incorporated, contractors and engineers of the project. Five additional reactors of the same size are part of the expansion program.

Kerr-McGee Oil Industries, Inc. has awarded more than $4 million in contracts for a 7350 BPD naphtha prefractionator, a 5500 BPD Platformer-Unifiner, and a 4000 BPD distillate Unifiner to be erected at the company's Wynnewood, Oklahoma, refinery. The Refinery Engineering Company has construction contracts and C. W. Nofsinger is handling engineering.

Imperial Chemical Industries plans a $4.2-million polyethylene plant at Sydney, Australia. Plant could eliminate about $2.8-million per year in polyethylene imports to that country.

Clark Oil & Refining Corporation has contracted Procon, Inc. to build a 12,500 BPD fluid catalytic cracker at the 30,000 BPD Blue Island, Illinois, refinery. Completion will be in early 1958; cost is $7¼ million, including gas processing facilities.

Cooperative Refinery Association is adding a 2500 BPD Platformer and a 3500 BPD Uniformer to its Phillipsburg, Kansas, refinery. Southwestern Engineering Company is handling the $1¼-million project, similar to one that it completed for CRA at Coffeyville, Kansas, last June. Completion is scheduled for December 1957.

Amoco Chemicals Company, Standard of Indiana's chemical subsidiary, is constructing a plant near Seymour, Indiana, to manufacture a "new, smokeless starter for jet aircraft engines." Using a process developed by the parent's research department, the plant will start operations in November 1957. Blaw-Knox is building the unit.

Mobil Overseas Oil Company, Inc., a Socony Mobil subsidiary, will build a 65,000 BPD refinery in Turkey scheduled for completion by 1960. Built at the request of the Turkish government to satisfy all of the country's petroleum product requirements, ownership will be divided among Mobil Overseas (37 percent), Caltex (34 percent), Shell (18 percent), and British Petroleum (11 percent).

Increased polyethylene capacity is just one of many expansion projects planned by Monsanto Chemical in 1957. Spending a total of $124 million for its own domestic expansion, jointly-owned U. S. companies, and foreign subsidiaries, plans include increasing its polyethylene capacity in Texas to 75-million lb per year.

Naugatuck Chemical Company has construction of a $7-million plant underway near Baton Rouge, Louisiana, for manufacture of plastic materials used in pipe, automotive parts, etc. The plant is being built by Nichols Construction Company and was designed by Walter Kidde Constructors. December 1957, completion is planned.

Escambia Chemical Corporation has a new research center under construction at Wilton, Connecticut, to be occupied in early 1958. The company presently uses National Research Corporation's facilities at Newton and Cambridge, Massachusetts, for research activities.

Cal-Mex Oil & Refining Company is taking options on a refinery site in the San Diego, California, area. The location is selected so that prevailing winds will not carry atmospheric effluent into populous areas. Design and engineering is underway, but no details have been disclosed.

Wyandotte Chemical Company is planning a $3-million plant for production of oxide products, including polyethers. Facilities will be located in Wyandotte, Michigan, and will have capacity for "several million pounds per year."

Ethyl research gains the spark

Unique instrumentation assures positive detection of misfiring

This Misfire Recorder accurately detects misfiring and records spark plug shunt resistance during a rating test. Pressure pulses in the exhaust system due to misfiring are picked up by a transducer and relayed to the instrument. Spark plug resistance is measured by a built-in megohmmeter.

This type of instrumentation was first applied to the detection of spark plug misfiring by Ethyl Research Laboratories. It has proved so satisfactory that many leading petroleum and automotive companies are now using the same instrumentation in their own laboratories.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

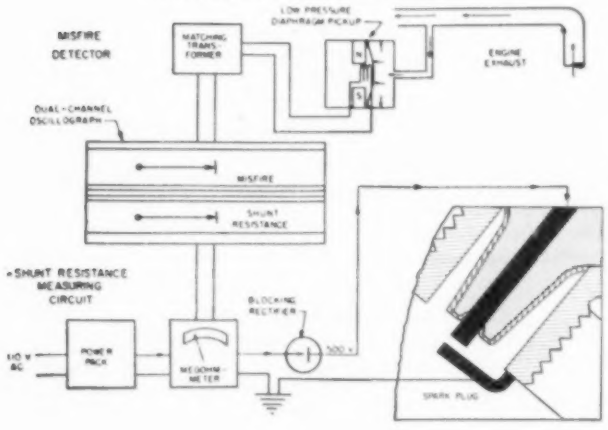
new insight into plug fouling problem

IT'S BEEN EVIDENT for some years that trends in engine design, as well as trends in urban and suburban traffic patterns, are intensifying the problem of spark plug fouling in passenger cars.

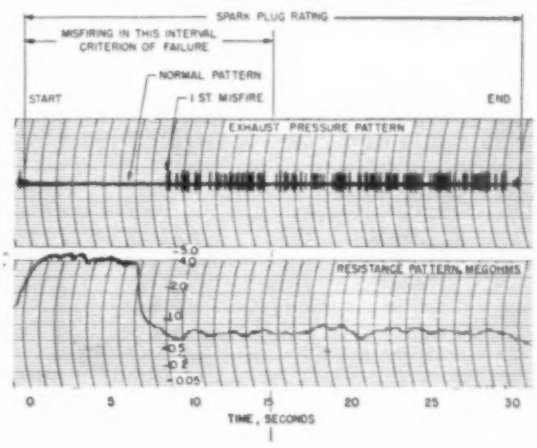
In the process of developing additives to help combat this problem, it became obvious to Ethyl engineers that previous laboratory methods for detecting and measuring spark plug misfire were inadequate. So Ethyl engineers created their own instrumentation—the unique device at the left.

Below is a diagram of the equipment, as well as a picture of the record this instrumentation produces when the transducer and megohmmeter outputs are fed into a dual-channel oscillograph:

Block Diagram of Spark-Plug Instrumentation



Actual Misfire and Shunt Resistance Patterns of a Fouled Spark Plug



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What processes are required to make fuels of the future?
How much money is involved?
Is two or three-grade gasoline marketing better?
Here is **A REFINERY VIEW OF**

Tomorrow's Fuels

S. P. Blumberg
Humble Oil and Refining Company, Baytown, Texas

EXTRAPOLATIONS of current trends indicate that high-performance cars of 1960 will require a premium motor fuel of approximately 110 Research octane number.

In the past 4 years the American public has consistently demonstrated through car purchases that it favors the high performance car,[1] with its improved maneuverability in traffic and its better acceleration on the highways.[2] These features are supplied through increases in horsepower obtained through many changes in design features, including increases in engine compression ratios. An increase in compression ratio is technically sound because it permits substantially more power and efficiency to be obtained from a given quantity of fuel.[3,4] This has been possible, however, only because the quality of fuels has advanced as required. Increases in compression ratio must be accompanied by increases in the octane number of the fuels employed.[5]

Trends in compression ratios[2,6] are shown in Fig. 1. Starting in 1946, the weighted average compression ratio of new cars increased at a rate of less than one-half compression ratio every four years. In 1953 a rather abrupt change occurred, and the average compression ratio of new cars started upward at a rate of one-half compression ratio per year.[7] An extrapolation of this trend indicates that by 1960 the average compression ratio of the new cars will be above 10:1 and that of the high-performance cars in the same year could exceed 12:1.[3]

By projecting recent octane requirement trends, it is estimated that the high-performance cars of 12:1 compression ratio will require a gasoline of approximately 110 Research octane number, and the average new car will require a gasoline of approximately 100 Research octane number.[2,6] Throughout this paper, octane numbers above 100 are expressed by the Wiese formula,

$$\text{octane number} = 100 + \frac{\text{PN} - 100}{3}.$$[8]

With existing octane-improvement facilities, refiners are now manufacturing premium-grade gasolines having 95 to 100 Research octane number. If the continued upward trend in automobile-engine compression ratios is maintained with corresponding increases in fuel octane number requirements, refiners are confronted with the task of planning future process requirements to meet a projected 10 to 15 Research octane increase in premium-grade gasolines. Accordingly, answers to these major questions are being sought:

1. Is it possible to manufacture in sufficient volume the forecasted high Research octane-number fuels to meet the requirements of future high-compression-ratio cars?
2. Can it be accomplished with current processes?
3. What investments and manufacturing costs will be incurred?

It is the purpose of this paper to discuss these questions from a refiner's viewpoint.

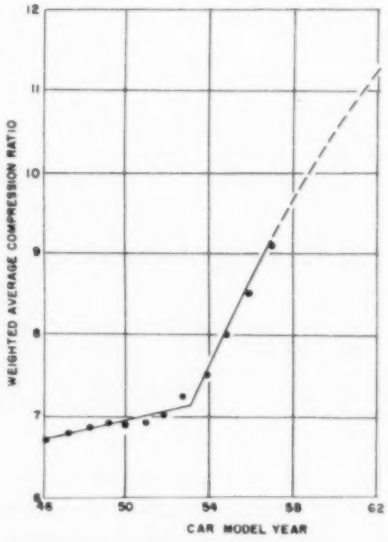

FIG. 1. Compression-ratio trend of new cars indicates that the average will be 10:1 by 1960. Premium fuels of about 110 RON may be required by some automobiles.

Refining Facilities

As a basis for the study, it was decided to consider a relatively small, new, and efficient refinery, constructed for the major purpose of producing increasingly higher octane-quality premium gasolines by the stepwise addition of established commercial octane-improvement processes.[9] The following assumptions were made concerning its operations: (1) That it would be an ultimate yield, inland refinery (away from tidewater) charging sour West Texas crude oil at a rate of 50,000 bbl per calendar day, and (2) that in the base case the processing equipment would consist of a two-stage pipe still, a fluid catalytic-cracking unit, a fluid-coking unit, a hydrofining unit,[10] a regenerative naphtha catalytic-reforming unit,[11] a light-ends and catalytic naphtha distillation system, and a propylene catalytic-polymerization unit.[12] Octane-improvement processes were added to the base refinery in four successive steps to manufacture the highest practicable octane gasoline pool, as follows:

Presented to a session on fuels during the 22nd Midyear Meeting of the American Petroleum Institute's Division of Refining, original title "A Refinery View of Fuels for the Future," Philadelphia, Pennsylvania, May 14, 1957.

Step I. An increase in catalytic-reforming severity was made to yield a total reformate of 100 instead of 95 Research octane number, clear, and a desulfurization unit[13] was added to pretreat the total catalytic-cracking gas-oil feed.

Step II. A sulfuric-acid alkylation unit was added to process segregated butylene and pentylene feeds.[9]

Step III. A superfractionation unit was added for fractionating the light virgin naphtha to yield *iso*pentane and *iso*hexane concentrates; an isomerization unit was added for processing the segregated *n*pentane and hexane concentrates.[14,15]

Step IV. An extraction unit was added for segregating the aromatics from the light and heavy reformate fractions.[16]

Fig. 2 presents a simplified flow diagram of the refinery.

Motor-Gasoline Blends

As the octane-improvement processes were added, there was an accompanying change in gasoline yield based on crude oil. To obtain a more realistic evaluation of the effects of increasing octane number, the entire refinery throughput and the processing capacities of individual units were adjusted so that the total gasoline production following installation of the facilities of each of the four steps was equal to that of the base case. In addition, each gasoline pool was further adjusted to a constant 10-lb Reid vapor pressure (RVP)

TABLE 1. Gasoline-Quality Data.

Step No.	Base	I	II	III	IV
Gasoline Volume, Bbl Per Calendar Day					
Total pool	←		29,729		→
Regular pool (70 percent)	←		17,837		→
Premium pool (30 percent)	←		11,892		→
Total Pool Quality					
Reid vapor pressure, lb (adjusted)	←		10		→
ATSM distillation, deg F:					
Percent evaporated at 158 F	30.1	32.9	30.6	34.0	32.2
50 percent evaporated	201	196	209	213	217
90 percent evaporated	344	334	331	332	350
Warmup-demerit rating	2.6	2.4	2.8	3.0	3.3
ATSM* octane number (D 908, Research Method):					
With the addition of 3 ml TEL per gal	98.0	99.4	100.5	102.2	102.5
ATSM octane number (D 357, Motor Method):					
With the addition of 3 ml TEL per gal	86.2	86.8	89.3	90.2	90.3
Sensitivity	11.8	12.6	11.2	12.0	12.2
Regular Pool Quality					
Reid vapor pressure, lb	←		10		→
ASTM distillation, deg. F:					
Percent evaporated at 158 F	←		30		→
50 percent evaporated	←		212		→
90 percent evaporated	←		332		→
Warmup-demerit rating	←		3.0		→
ASTM octane number (D 908, Research Method):					
With the addition of 3 ml TEL per gal	98.0	98.5	99.0	99.5	99.5
ASTM octane number (D 357, Motor Method):					
With the addition of 3 ml TEL per gal	86.0	86.5	87.0	87.5	87.5
Sensitivity	←		12		→
Premium Pool Quality					
Reid vapor pressure, lb	←		10		→
ASTM distillation, deg F:					
Percent evaporated at 158 F	30.3	39.7	32.0	43.3	37.0
50 percent evaporated	180	166	202	213	238
90 percent evaporated	340	328	320	320	349
Warmup-demerit rating	2.0	1.5	2.4	2.8	4.2
ASTM* octane number (D 908, Research Method):					
With the addition of 3 ml TEL per gal	98.0	102.4	105.4	109.4	110.8
ASTM* octane number (D 357, Motor Method):					
With the addition of 3 ml TEL per gal	86.6	88.6	99.0	101.6	102.0
Sensitivity	11.4	13.8	6.4	7.8	8.8

*Octane numbers above 100 by the Wiese formula, octane number $= 100 + \frac{FN - 100}{3}$.

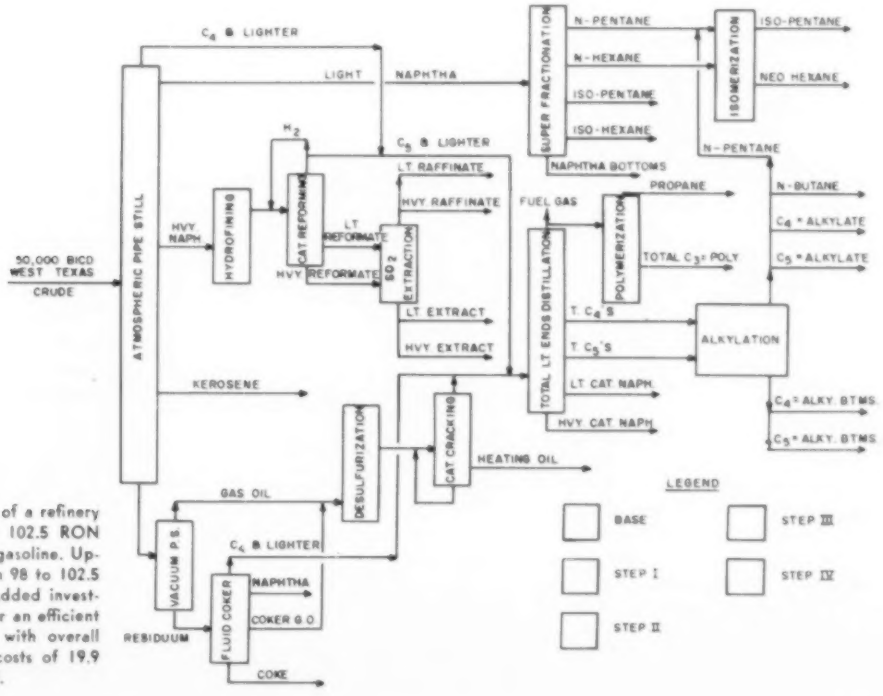

FIG. 2. Flow diagram of a refinery designed to produce 102.5 RON (@ 3 cc TEL) motor gasoline. Upgrading the pool from 98 to 102.5 RON would require added investment of $18-million for an efficient 50,000 BPD refinery, with overall octane-improvement costs of 19.9 cents per RON-barrel.

by either the removal of mixed butanes or the addition of purchased *n*butane. Finally, each constant-RVP-constant-volume gasoline pool was arbitrarily divided into premium and regular grades in 30:70 and 40:60 volume ratios by appropriate blending of the various refinery streams. These ratios were selected to bracket the current 31:69 ratio of premium to regular gasoline sales and an anticipated upward trend on this ratio as octane requirements increase in the future.

Octane and distillation characteristics of all the components produced in the various situations considered were known, and corresponding values were calculated for the total pools. When total pools were divided into 30 percent premium and 70 percent regular grades, the Research and Motor octane numbers of the regular pools were allowed to increase gradually from the base through Step IV from 98.0 to 99.5 and from 86.0 to 87.5, respectively. In the division of the pools into 40 percent premium and 60 percent regular grades, the Research and Motor octane values of the regular grades were maintained constant at 98.0 and 86.0, respectively, to permit production of the same quality premium fuels as were produced with the 30:70 ratio of premium-to-regular fuel division. In all cases the volatility characteristics of the regular grades were maintained constant.

Volatilities and octane qualities of the total, premium, and regular fuels for the 30:70 and 40:60 divisions are presented in Table 1 and Table 2, respectively. It was found that all of the regular and premium fuels represented practical blends which could be produced in the refinery facilities employed.

Volatility and octane qualities of the total, regular, and premium fuels for each of the steps shown in Table 2 are summarized as follows:

TABLE 2. Gasoline-Quality Data.

Step No.	Base	I	II	III	IV
Gasoline Volume, Bbl Per Calendar Day					
Total pool	←		29,729		→
Regular pool (60 percent)	←		17,837		→
Premium pool (40 percent)	←		11,892		→
Total Pool Quality					
Reid vapor pressure, lb (adjusted)	←		10		→
ASTM distillation, deg F:					
Percent evaporated at 158 F	30.1	32.9	30.6	34.0	32.2
50 percent evaporated	201	196	209	213	217
90 percent evaporated	344	334	331	332	350
Warmup-demerit rating	2.6	2.4	2.8	3.0	3.3
ASTM* octane number (D 908, Research Method):					
With the addition of 3 ml TEL per gal	98.0	99.4	100.5	102.2	102.5
ASTM octane number (D 357, Motor Method):					
With the addition of 3 ml TEL per gal	86.2	86.8	89.3	90.2	90.3
Sensitivity	11.8	12.6	11.2	12.0	12.2
Regular Pool Quality					
Reid vapor pressure, lb	←		10		→
ASTM distillation, deg F:					
Percent evaporated at 158 F	←		30		→
50 percent evaporated	←		212		→
90 percent evaporated	←		332		→
Warmup demerit rating	←		3.0		→
ASTM octane number (D 908, Research Method):					
With the addition of 3 ml TEL per gal	←		98		→
ASTM octane number (D 357, Motor Method):					
With the addition of 3 ml TEL per gal	←		86		→
Sensitivity	←		12		→
Premium Pool Quality					
Reid vapor pressure, lb	←		10		→
ASTM distillation, deg F:					
Percent evaporated at 158 F	30.3	37.3	31.5	40.0	35.5
50 percent evaporated	193	184	206	213	228
90 percent evaporated	342	330	325	325	348
Warmup-demerit rating	2.4	1.9	2.6	2.9	3.7
ASTM* octane number (D 908, Research Method):					
With the addition of 3 ml TEL per gal	98.0	102.4	105.4	109.4	110.8
ASTM* octane number (D 357, Motor Method):					
With the addition of 3 ml TEL per gal	86.6	88.6	98.0	103.5	104.3
Sensitivity	11.4	13.8	6.4	5.9	6.5

*Octane numbers above 100 by the Wiese formula, octane number $= 100 + \frac{PN - 100}{3}$.

that the Research octane number of the Step IV premium grade is equivalent to the value forecasted for 12:1 compression-ratio cars. As shown in the Table 2 summary, the warmup demerits for the premium fuels increased significantly in going from the base case to Step IV. Except for this, the study indicates that installation of currently available processes, coupled with operation

Pool and Step	RVP (lb)	Percent Evaporated at 158 F	Warmup Demerit	ASTM* Octane Number With the Addition of 3Ml TEL Per Gal: Research	Motor	Sensitivity
Total Pool						
Base	10	30	2.6	98.0	86.2	11.8
Step IV	10	32	3.3	102.5	90.3	12.2
Regular Pool (60 Percent)						
All steps	10	30	3.0	98.0	86.0	12.0
Premium Pool (40 Percent)						
Base	10	30	2.4	98.0	86.6	11.4
Step IV	10	36	3.7	110.8	104.3	6.5

*Octane numbers above 100 by the Wiese formula, octane number $= 100 + \frac{PN - 100}{3}$.

It will be noted that the cumulative effect of the octane-improvement processes is to upgrade the Research octane number of the total pool from 98.0 to 102.5 and that of the premium pool from 98.0 to 110.8. It is to be noted at high-severity levels, may well answer the needs of the refiners to meet future required octane qualities up to this point.

In recent years, trends in engine design have resulted in an increase in the speed of knock, and Motor octane ratings relative to Research octane ratings have become greater factors in road-octane performance. As a result, it may become increasingly important to maintain the sensitivity of the gasolines at a value of 10 or less in the future.[17] As anticipated, premium-fuel sensitivity increased when reforming severity was increased (11.4 to 13.8; Step I over base), and then decreased significantly as alkylation was added.[11] Sensitivity following Step IV was only 6.5.

It should be emphasized that Step IV represents utilization of a large amount of alkylate in motor gasoline relative to normal refinery practices. For example, the target Research octane quality of 110 can be met without the use of alkylate, as shown in Table 3. In this case, the use of a large amount of aromatics resulted in a sensitivity of 10.0. On this basis it would be questionable for car manufacturers to rely upon a sensitivity of less than 10.

Vapor-lock and warmup characteristics of a fuel are known to be influenced by its RVP and distillation characteristics. Vapor-locking tendencies of

a fuel are often characterized by its vapor pressure and the percentage evaporated at 158 F, as described in a paper by Barnum, Clarke, and Hamer.[18] All of the fuels in Table 2 are reasonably similar and are satisfactory from the standpoint of vapor lock. Warmup characteristics of a gasoline are controlled primarily by mid and backend volatilities. Moore, Young, and Toulmin have correlated warmup performance with ambient temperature and the 50 percent and 90 percent evaporation temperatures of the fuel.[19,20] This correlation was employed to obtain the warmup-demerit ratings shown in Tables 1, 2, 3, and 5. Fuels with high 50 percent and 90 percent distillation temperatures exhibit poor warmup characteristics and, consequently, have the highest demerit ratings. It is important to note that the warmup-demerit rating of the premium fuels increased from 2.0 to 4.2 for the base case over Step IV (Table 1) and from 2.4 to 3.7 for the base case over Step IV (Table 2). The rapid rise in demerit rating was experienced as the concentration of the high-boiling, high-octane alkylates and aromatics was increased. This emphasizes the fact that the warmup problem will likely gain in importance as the octane levels continue to rise.[19]

Octane-Improvement Costs

As stated in the introduction, the refiner is concerned with the magnitude of the investments and operating costs that will be incurred in meeting the future octane requirements. Investments and operating costs are quite specific to any refinery, and a detailed consideration of a single refinery would not likely yield information of general applicability. Moreover, there are uncertainties as to future costs and product values. In a partial attempt to indicate an order of magnitude of future octane-improvement costs, the generalized 50,000 bbl per calendar day refinery was selected. It was estimated that this refinery would cost $46 million, or approximately $920 per daily bbl of crude-oil charging capacity; this figure is believed to be within the range of costs of constructing such a refinery today. Estimates of investments for integrating the processing facilities for each successive step considered would be expected to vary substantially, depending upon the existing situation and the expected ultimate situation. Accordingly, a single estimate was prepared, covering the cost of a new refinery containing all of the facilities through Step IV. This investment would be on the order of $64 million, which is some 39 percent greater than that for the base refinery, for the same motor-gasoline production but of the higher octane quality. Operating costs and product values were selected as being reasonably typical of the assumed situations. In order to obtain an indication of the cost of octane improvement, refinery realizations on all products except premium gasoline were held constant. Raw-stock costs, operating costs, and product values for the base case and for completion of Step IV facilities are presented in Table 4.

The results presented in Table 2 and Table 4 for the base and Step IV are summarized as:

Step No.	Base	IV
Premium Gasolines		
Qualities		
ASTM* octane number (D 908, Research Method): With the addition of 3 ml TEL per gal	98.0	110.8
ASTM* octane number (D 357, Motor Method): With the addition of 3 ml TEL per gal	86.6	104.3
Mfg. cost, cents per gal	12.5	18.6
Octane-Improvement Costs		
Research above base, cents per Research octane-number bbl		19.9
Motor above base, cents per Motor octane-number bbl		14.4

*Octane numbers above 100 by Wiese formula, octane number $= 100 + \frac{PN - 100}{3}$.

The inclusion of all the improvement processes in Step I through Step IV effected an increase in the Research and Motor octane numbers of 12.8 and 17.7, respectively, for an added cost of 6.1 cents per gal. This is equivalent to Research octane-number barrel and Motor octane-number barrel improvement costs of 19.9 cents and 14.4 cents, respectively. These costs are not to be considered additive, inasmuch as each

TABLE 3. Octane-Quality Data of Experimental Blends.

	Blend No. 1	Blend No. 2	Blend No. 3
Component Composition, Percent by Volume			
Light isoparaffins (C_4, C_5, and C_6)	42	28	35
Mixed alkylate	20	20	
Purified aromatics (toluene, xylene, and C_9)	38	52	65
Inspection Data			
Reid vapor pressure, lb	11.2	12.3	12.3
ASTM distillation, deg F:			
Percent evaporated at 158 F	18	23	25
50 percent evaporated	242	238	217
90 percent evaporated	300	300	302
Warmup-demerit rating	3.9	3.5	2.6
ASTM* octane number (D 908, Research Method):			
With the addition of 3 ml TEL per gal	105	107	110
ASTM octane number (D 357, Motor Method):			
With the addition of 3 ml TEL per gal	100	99	100
Sensitivity	5	8	10

Octane numbers above 100 by the Wiese formula, octane number $= 100 + \frac{PN - 100}{3}$.

TABLE 4. Material Balance, Economics, and Investments.*

	Base			IV		
Step No.	Bbl Per Calendar Day	Cents Per Gal	Dollars Per Calendar Day	Bbl Per Calendar Day	Cents Per Gal	Dollars Per Calendar Day
Raw Stock and Degradation Costs						
Crude oil	50,000	7.26	152,500	45,165	7.26	137,753
nButane	.....	.....	.....	1,272	5.00	2,671
Isobutane	.....	.....	.....	2,102	8.00	7,062
Gas (or equivalent fuel)†	(3,104)	0.15†	(2,794)	(2,343)	0.15†	(2,109)
LPG (C_3)	(1,309)	3.50	(2,012)	(1,328)	3.50	(1,952)
Mixed C_4's	(1,982)	10.00	(8,324)		10.00	.....
Kerosine	(7,300)	7.50	(22,995)	(7,651)	7.50	(24,101)
Heating oil	(7,544)	7.00	(22,179)	(7,524)	7.00	(22,121)
Coke‡	(966)	11.00‡	(2,596)	(900)	11.00‡	(2,343)
Gasoline, regular	(17,837)	12.50	(93,644)	(17,837)	12.50	(93,644)
Loss	2,024	.....	.....	936	.....	.....
Gasoline, premium§	(11,892)	.....	.....	(11,892)	.....	.....
Net Costs¶	0	.....	(2,044)	0	.....	1,216
Operating Costs	.....	.....	39,191	.....	.....	56,504
Premium Gasoline	11,892	12.50	62,432	11,892	18.57	92,745
Total Investment, In Millions of Dollars	.....	.....	46	.....	.....	64

*Figures in table which appear in parenthesis are credits.
†Fuel-gas value, at 15 cents per million Btu.
‡Coke value, at $11 per ton.
§Costs established by difference as shown previously.
¶Net costs or credits, excluding premium gasoline.

was calculated from the same difference (6.1 cents per gal) in manufacturing cost. It can be observed in Table 2 that all of the added processes contributed almost equally to the rise in the Research octane number of the premium pool; however, the Motor octane increase was gained primarily through the use of alkylate. If the sensitivity of a fuel continues to exhibit an important influence on its road-octane rating, refiners will continue to examine all processes from the standpoint of both types of octane-improvement costs. The study indicates that obtaining further increases in octane quality will become much more difficult and considerably more expensive.[21]

Effect of Producing Aviation Gasoline

Many refineries have commitments to supply aviation gasoline as well as two or more grades of motor gasoline. An analysis was made to determine the quality effect on the premium motor-gasoline pool, if sufficient components were first made available for the production of 10 percent of grade 115/145 aviation fuel; and the remaining pool, after a readjustment to 10-lb RVP, was then divided into 40 percent premium and 60 percent regular-grade motor fuels. Table 5 presents the distillation and octane qualities obtained for Step II, Step III, and Step IV. These data may be compared with data from Table 2 as:

TABLE 5. Effect of Producing 10 Percent Aviation Gasoline.

Step No.	II	III	IV
Total Gasoline-Pool Volume, Bbl Per Calendar Day	←	29,729	→
Regular	←	15,941	→
Premium	←	10,628	→
Aviation grade 115/145	←	2,973	→
Aviation Grade 115/145 Quality			
Reid vapor pressure, lb	←	7	→
ASTM distillation, deg F:			
Percent evaporated at 158 F	←	30	→
50 percent evaporated	←	205	→
90 percent evaporated	←	287	→
Warmup-demerit rating	←	1.7	→
ASTM* octane number (D 908, Research Method):			
With the addition of 3 ml TEL per gal	←	108.0	→
ASTM* octane number (D 357, Motor Method):			
With the addition of 3 ml TEL per gal	←	102.0	→
Sensitivity	←	6	→
Regular Pool Quality†			
Premium Pool Quality			
Reid vapor pressure, lb	←	10	→
ASTM distillation, deg F:			
Percent evaporated at 158 F	29.9	33.6	31.6
50 percent evaporated	212	123	238
90 percent evaporated	300	295	357
Warmup-demerit rating	2.4	2.3	3.6
ASTM* octane number (D 908, Research Method):			
With the addition of 3 ml TEL per gal	103.6	107.0	108.3
ASTM octane number (D 357, Motor Method):			
With the addition of 3 ml TEL per gal	94.6	97.3	97.7
Sensitivity	9.0	9.7	10.6

*Octane numbers above 100 by the Wiese formula, octane number $= 100 + \frac{PN - 100}{3}$.

†The same quality as shown in Table 2.

As would be expected, losses in Research octane (1.8 to 2.5), Motor octane (4.4 to 6.6), and midvolatility (6 F to 10 F) and substantial increases in sensitivity (2.6 to 4.1) occurred when alkylate was removed to produce aviation fuel. These data serve to emphasize again that future premium gasolines may well have sensitivities above 10, if the production of aviation gasoline remains at substantial levels.

Step No.	II (Percent)		III (Percent)		IV (Percent)	
Aviation Gasoline Sales	0	10	0	10	0	10
Premium Fuels						
ASTM* octane number (D 908, Research Method):						
With the addition of 3 ml TEL per gal	105.4	103.6	109.4	107.0	110.8	108.3
ASTM* octane number (D 357, Motor Method):						
With the addition of 3 ml TEL per gal	99.0	94.6	103.5	97.3	104.3	97.7
Sensitivity	6.4	9.0	5.9	9.7	6.5	10.6
ASTM distillation, deg. F:						
50 percent evaporated	206	212	213	213	228	238

*Octane numbers above 100 by the Wiese formula, octane number $= 100 + \frac{PN - 100}{3}$.

TABLE 6. Effect of Three-Grade System Gasoline Marketing.

	Percent by Volume of Total Pool	ASTM* Octane Number (D 908, Research Method): With the Addition of 3 Ml TEL Per Gal	ASTM* Octane Number (D 357, Motor Method): With the Addition of 3 Ml TEL Per Gal	Reid Vapor Pressure (lb)
Three-Grade—Step II				
First grade	15	110.8	101	10
Second grade	35	102.4	89	10
Third grade	50	98.0	86	10
Two-Grade—Step IV				
Premium	40	110.8	104.3	10
Regular	60	98.0	86.0	10

*Octane numbers above 100 by the Wiese formula, octane number $= 100 + \frac{PN - 100}{3}$.

Effect of a Three-Grade System for Marketing Motor Gasoline

A number of gasoline manufacturers are currently marketing three grades of motor fuel while others are continuing to market only two grades. To show the effect of employing a three-grade system, the total gasoline pool of Step II was divided into three grades according to the percentage figures shown in Table 6. The Research octane numbers of the first and third grades were fixed, and the second grade was then calculated by the difference. The Research octane number of the first and third-grade fuels purposely were selected to be identical to the premium and regular grades of Step IV in Table 2. It should be noted that by dividing the Step II pool into three grades, a manufacturer could satisfy essentially the same percentage of high and low-compression-ratio cars as the two-grade system of Step IV, without a substantial additional refinery investment for facilities such as isomerization and extraction of catalytic reformates.

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★ ★ ★

Premium Gasoline Now Averages 97.3 RON According to DuPont Quarterly Survey

Premium gasoline for the entire country showed a weighted average of 97.3 Research octane number. Weighted regular average was 90.

Highest premium sample showed 100.9 Research octane number. Highest premium average was at Corpus Christi, Texas, 98.6 Research. Boston showed 92.9 regular, Norfolk, 92.7, New York City, 92.6. Toronto showed the highest in Canada, 96.2 for premium, regular 91.3, checking with Montreal.

Average TEL for regular was 2.09 cc; for premium the average was 2.44, a difference of 0.35 cc. This survey was made on 805 fuels—397 premium and 408 regular gasolines.

MOTOR GASOLINE SURVEY, APRIL 1957
(DuPont)

	Premium			Regular		
	Octane No.		TEL	Octane No.		TEL
	Motor	Research	Content	Motor	Research	Content
Aberdeen, S. D.	86.0	96.0	2.29	83.0	88.1	1.69
Albuquerque, N. M.	86.4	96.3	2.59	82.8	86.8	2.37
Amarillo, Tex.	87.0	96.9	2.47	83.6	88.7	2.25
Atlanta, Ga.	88.1	98.2	2.37	84.3	89.7	2.28
Bakersfield, Calif.	88.0	96.1	2.90	80.6	86.5	2.60
Baltimore, Md.	87.4	98.4	2.35	84.7	92.3	2.19
Boise, Idaho	85.7	96.4	2.27	81.6	86.9	1.72
Boston, Mass.	87.7	98.3	2.37	85.5	92.9	2.19
Calgary, Alta.	85.7	92.7	2.56	80.3	86.6	2.38
Casper, Wyo.	84.8	94.8	2.34	81.0	87.0	1.96
Charlotte, N. C.	87.7	98.4	2.35	84.3	90.0	2.33
Chicago, Ill.	87.5	97.2	2.48	84.9	91.1	2.31
Cincinnati, Ohio	88.0	97.6	2.62	84.2	91.2	1.98
Cleveland, Ohio	88.9	98.1	2.67	84.5	91.5	2.25
Columbus, Ohio	87.9	98.4	2.76	84.5	91.4	2.32
Corpus Christi, Tex.	87.6	98.6	2.85	84.4	89.1	2.49
Dallas—Ft. Worth ,Tex.	87.7	98.1	2.70	82.4	88.9	2.21
Davenport, Ia.	87.4	95.5	2.49	83.3	88.9	1.90
Denver, Colo.	84.9	94.1	2.06	81.2	85.9	1.60
Des Moines, Ia.	86.4	95.6	2.20	83.3	88.0	2.14
Detroit, Mich.	—	—	—	—	—	—
Edmonton, Alta.	83.8	92.6	1.69	80.6	86.5	1.69
El Paso, Tex.	86.5	96.7	2.50	82.9	87.5	2.21
Great Falls—Billings, Mont.	83.7	94.4	1.73	79.7	87.8	1.69
Houston, Tex.	87.8	98.4	2.70	84.2	89.7	2.11
Indianapolis, Ind.	88.4	97.9	2.86	83.8	90.9	2.15
Jacksonville, Fla.	88.1	98.1	2.36	84.4	91.4	2.12
Kansas City, Mo.	87.5	96.4	2.48	83.2	88.0	1.88
Little Rock, Ark.	87.5	98.2	2.64	83.6	89.1	2.72
Los Angeles, Calif.	85.9	97.2	2.61	79.8	87.0	1.37
Louisville, Ky.	87.7	97.5	2.68	83.5	89.3	1.95
Memphis, Tenn.	87.9	97.9	2.61	84.2	89.4	2.22
Milwaukee, Wis.	88.2	97.2	2.66	84.9	90.9	2.39
Minneapolis, Minn.	86.7	96.3	2.44	82.5	88.4	1.51
Montreal, Que.	85.9	96.0	1.97	83.9	91.3	1.28
Nashville, Tenn.	87.7	98.1	2.78	83.2	89.2	2.25
New Orleans, La.	87.1	97.9	2.78	83.4	89.0	2.50
New York, N. Y.	87.4	97.8	2.29	84.9	92.6	1.84
Norfolk, Va.	88.2	98.1	2.43	85.5	92.7	2.30
Omaha, Neb.	86.9	95.5	2.35	83.7	87.8	2.17
Philadelphia, Pa.	87.6	97.8	2.31	84.4	92.2	1.83
Pittsburgh, Pa.	87.9	97.8	2.32	85.2	92.5	2.51
St. Louis, Mo.	87.3	95.9	2.40	84.7	90.3	2.26
Salt Lake City, Utah	85.8	94.3	1.95	80.6	84.4	1.76
San Francisco, Calif.	86.3	96.9	2.37	81.3	87.4	1.25
Seattle, Wash.	85.7	96.5	1.90	81.7	88.0	1.32
Shreveport, La.	87.2	98.3	2.77	83.6	89.1	2.53
Spokane, Wash.	85.0	96.6	1.77	81.5	87.7	1.31
Syracuse, N. Y.	87.9	98.1	2.20	84.9	92.4	1.72
Toronto, Ont.	86.6	96.2	2.21	83.5	91.3	1.33
Tulsa—Okla. City, Okla.	86.9	95.9	2.45	83.5	88.0	2.05
Vancouver, B. C.	85.0	95.9	1.62	82.6	88.6	1.40
Wichita, Kans.	86.9	95.8	2.59	84.3	87.7	2.26
Winnipeg, Man.	85.3	95.4	2.26	82.2	89.0	1.12

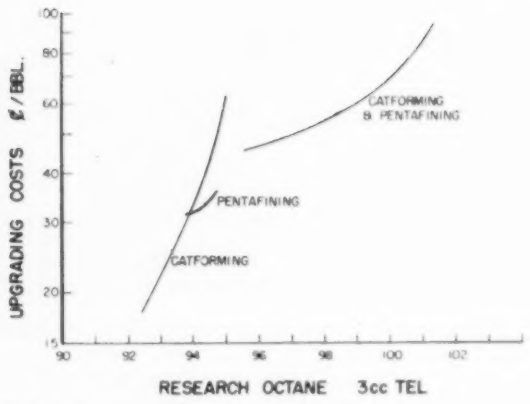


FIG. 1. Process yield-octane relationships for catalytic reforming and isomerization of 12.5 RVP natural gasoline.

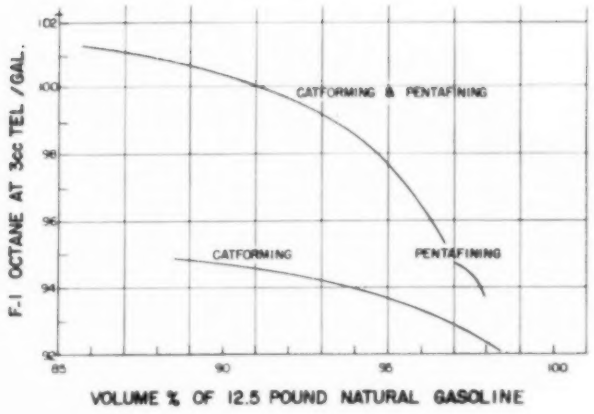


FIG. 2. Pool octane costs for upgrading natural gasoline to 15.5 RVP high-octane blending component.

CATALYTIC PROCESSING IN NATURAL GASOLINE PLANTS

Many natural gasoline plant operators are or will be looking to catalytic processing to answer problems relating to today's fiercely competitive, high-octane gasoline market. Texas Gas Corporation is able, for example, to turn out a considerable volume of 100 Research octane gasoline at its Winnie, Texas, plant, giving them great flexibility in marketing operations (February, 1957, RE, page C-26). There are now five catalytic reforming units operating in natural gasoline plants, as follows:

- Texas Gas Corporation, Winnie, Texas — 2500 BPD
- Arkansas Fuel Oil Corporation, Carthage, Texas — 1000 BPD
- Southwest Gas Producing Company, Dubach, Louisiana—1500 BPD
- Dorchester Corporation, White Deer, Texas — 1000 BPD
- South Hampton Company, Silsbee, Texas — 700 BPD.*

In addition, Atlas Processing Corporation brings in a lot of natural gasoline for processing in its 8000 BPD catalytic reformer at Shreveport, Louisiana, in combination with crude oil processing in this case. And, many more units for catalytic upgrading of natural gasoline are either in the construction or drawing-board stages.

What does catalytic processing mean to the natural gasoline processor, yield and product quality-wise? Atlantic Refining Company spokesmen J. A. Nevison, H. H. Zachow, and D. C. Benedict answered this question in a paper "Octanes for Today and Tomorrow," presented at the recent NGAA national meeting in Houston. To illustrate the benefits of catalytic reforming and catalytic isomerization, they set up a case based on processing 3000 BPD of 12.5 RVP natural gasoline, containing 4.7 percent butanes, 64.8 percent C_5-C_6 (to isomerization), and 30.5 percent C_7 and heavier (to catalytic reforming).

Yield-octane relationships and ultimate octane levels for various combinations of catalytic reforming and isomerization are shown in Fig. 1. The Atlantic spokesmen pointed out that each of the schemes was used to process the appropriate fraction of gasoline and the remainder of the naphtha reblended and pressured to 12.5 RVP — thus these curves represent processing losses not only to materials not in the gasoline boiling range but also to losses due to changes in product vapor pressure.

Pool octane costs are illustrated in Fig. 2, and include labor, operating utilities, royalties, maintenance, of losses. For isomerization alone it was assumed that hydrogen was available at fuel prices.

Conversion of these figures to the premium that must be paid for these octanes requires that amortization of the investment and profit must be added. Atlantic's figures showed that combined isomerization and reforming units would cost about $875,000, with five year amortization requiring a premium of 66 cents per barrel at 96 pool octane and 91 cents at 100 octane above prevailing natural gasoline prices. Built separately, investment for a catalytic reforming unit would be about $440,000 and $610,000 for pentane-hexane isomerization.

In addition to the obvious Research octane benefit, the Atlantic report emphasized the excellent Motor Method octane ratings afforded by these stocks as a motor gasoline blending component. The trend is toward engines that are more sensitive to Motor octane; the processed natural gasoline has a sensitivity (RON minus MON) of only 2 at 90 Research, little more than 5 at 102 Research octane. This is much lower than today's premium gasolines, which havs sensitivities of 10 octane numbers, on the average.

*The South Hampton unit is independently-owned; it draws feedstock from the adjacent Silsbee gasoline plant (Dec., 1956, RE, p. C-9).

Regeneration of catalyst permits lower-pressure operations, results in higher gasoline yields

Regenerative Platinum Catalyst Reforming

H. C. Nix

Humble Oil and Refining Company, Baytown, Texas

The increased octane requirements of modern automobiles have created the need for refining processes capable of producing economical high-octane gasoline components. In selecting a process, it is logical to consider reforming which has long been known as a means of converting low-octane virgin naphthas to high-octane products. Primary reaction involved is that of naphthene dehydrogenation to aromatics; paraffin isomerization, dehydrocyclization, and hydrocracking reactions are of lesser but significant importance. Generally, the early reformers were built during World War II in order to produce toluene for TNT and aviation gasoline. One of the first units was built at Baytown, Texas; it was operated and later purchased by the Humble Oil and Refining Company from the United States government.

These units, called hydroformers, used a molybdena-on-alumina catalyst in a cyclic regenerative fixed bed. However, the relatively low product yields obtained with the molybdena catalyst made fixed-bed molybdena reforming an expensive process for gasoline octane improvement. The development of superior platinum-on-alumina catalysts has revolutionized reforming. Their development has been the key to the production of modern premium gasolines, and there are now many types of platinum-catalyst reforming processes commercially available.[1]

In June 1955 the Humble Oil and Refining Company installed a new 20,000-bbl-per-stream-day platinum reformer which used a platinum-on-alumina catalyst developed by the Standard Oil Company (Indiana). In August of the same year, Humble's older molybdena reformer was converted for the use of the same platinum catalyst, also at a design charge rate of 20,000 bbl per stream day. Process design of these units was done by Humble.

[1] Presented during the 22nd Midyear Meeting of the American Petroleum Institute's Division of Refining, May 16, 1957, under the same title.

Process Description

Humble's two platinum reformers can best be described as fixed-bed, regenerative catalytic reformers utilizing a platinum-in-alumina catalyst. The oil flow is simple. Fresh naphtha and a hydrogen-rich recycle gas are heated and passed through several reaction and reheat stages. Because the reforming reactions are primarily endothermic, reheating of the reactants is required between the reactors. Naphthene dehydrogenation is the most highly endothermic reaction which occurs. Most of this reaction is completed in the first reactor. Therefore, a large temperature drop is experienced across the first reactor, with less temperature drop across each subsequent reactor.

The regenerative feature of the catalyst helps to make possible the following range of operating conditions:

1. Feed rate, bbl per stream day 20,000
2. Recycle-gas ratio, std cu ft per bbl of fresh feed . 3500 to 6000
3. Average reactor pressure, psig . . . . . 200 to 325
4. Reactor inlet temperature, deg F . . . . . 840 to 960
5. Design product Research octane number, clear 93
6. Ultimate product Research octane number, clear . 100+

The previously mentioned typical reforming reactions occur, and the following products are formed:

1. A hydrogen-rich gas suitable for use in a hydrogen treater, or as a fuel gas.
2. Light hydrocarbons — propane, butanes and pentanes.
3. A high-octane gasoline fraction, containing a small quantity of polymer which requires removal.

The special regenerative feature of the platinum catalyst used makes possible low-pressure operations which result in higher yields for a given product octane number. As the low-pressure operations produce a greater amount of coke for a given severity, the catalyst deactivation is more rapid in this process than in high-pressure (approximately 600 psig), nonregenerative types of platinum reformers. Inasmuch as the catalyst activity can be restored by a simple regeneration, high-severity operations are possible, and a lower recycle-gas ratio can be used. Long-term activity maintenance and strength characteristics of this catalyst make frequent regenerations possible, to maintain high activities and product yields.

Unit Design

A. Hydrocarbon System.

1. *Feed preparation.* Reformer feed-preparation facilities are located at a separate unit. The virgin-naphtha pipestill fraction from a mixture of Texas crude oils is, at present, partly desulfurized to approximately 100 ppm of sulfur. It is then fractionated into three successive narrow cuts, boiling in the range from 200 F to 370 F. The lightest of these feeds, boiling from 200 F to a final boiling point of 270 F, is charged preferentially to the converted hydroformer, which has a pressure limitation of approximately 250 psig. The other two feeds, boiling from 260 F to 310 F and 300 F to 370 F, are charged in blocked operations to the new reformer. This unit is capable of operating at approximately 325 psig. It is planned to install a hydrodesulfurization unit which will reduce the feed sulfur level to less than 25 ppm. Reasons for this change will be discussed later.

2. *Reaction system.* Reaction system consists of feed and recycle-gas preheat furnace, three or more reheat furnaces, reactors, feed-reactor effluent heat exchangers, recycle-gas compress-

ors, and a high-pressure separator. A simplified flow diagram is presented in Fig. 1. Fresh feed is heated in the feed-reactor effluent exchangers and feed preheat furnace. It is then mixed with recycle gas which has been compressed and heated separately in the same way. The mixture of recycle gas and fresh feed goes through four reactors in series and a reheat furnace between each reactor. The effluent from the last reactor exchanges heat with the fresh feed and recycle gas. It is cooled and flashed in a high-pressure separator. The recycle-gas compressors take suction from this separator, and the liquid product is ready for stabilization. The pressure of the reaction is controlled by regulating the flow of the make gas from the separator. Currently, only three reaction stages are installed at the converted reformer. An additional reactor and reheat furnace will be installed this year.

3. *Product recovery.* Product-recovery system used in Humble's platinum reformers consists of a depentanizer which stabilizes the liquid product from the high-pressure separator. The unique feature of the depentanizing towers is that they are equipped to produce a vapor side stream at about three trays above the tower bottom. When it is desired to produce a stabilized reformate suitable for direct motor-gasoline blending, a side-stream cut is produced. Approximately 80 percent of the 430 F+ polymer material, which is normally in the reactor product, is removed when the reformate is produced as a vapor side stream. Normally, most of the reformate from the company's reformers is fractionated in other units for production of aromatic solvents and blend components of aviation as well as motor gasoline. Complete polymer removal is accomplished in this operation.

B. Regeneration System.

A common regeneration system is provided for the two reformers. The system is so designed that a reactor can be regenerated at one unit while a reactor is being prepared for regeneration or reaction at the other unit. Sizable time savings are thus achieved. A spare or swing reactor is provided at both reformers. Therefore, no interruption in oil processing occurs as a result of regeneration. A high-pressure flue-gas generator supplies the unit gases used in regeneration. These gases are circulated with a flue-gas blower while the air requirements for regeneration are supplied by reciprocating compressors. A more detailed description of the regeneration operation will be presented later.

C. Special Safety Controls.

In order to prevent the hazard of mixing regeneration gases and hydrocarbon vapors, the reactors are provided with double deck valves and a seal-gas system. When a reactor is on reaction, the regeneration valves are closed and an elevated pressure maintained between the valves with an inert seal gas. When a reactor is being regenerated, its hydrocarbon valves are closed in the same way. The seal-gas system is provided with flow, pressure, and temperature recorders and alarms. The double valve system is of supreme importance as it makes possible blinding off one reactor from service, for repairs or catalyst change, without affecting the rest of the unit.

Hydrocarbon valves for each reactor are motor-operated and pushbutton-controlled from the control room. One of the regeneration valves is motor-operated and the other is hand-operated. These valves are interlocked electrically to prevent errors in the sequence of valve operation. Oxygen recorders are on the inlet and outlet regeneration gas stream, and each reactor is provided with temperature recorders for observing regeneration temperatures.

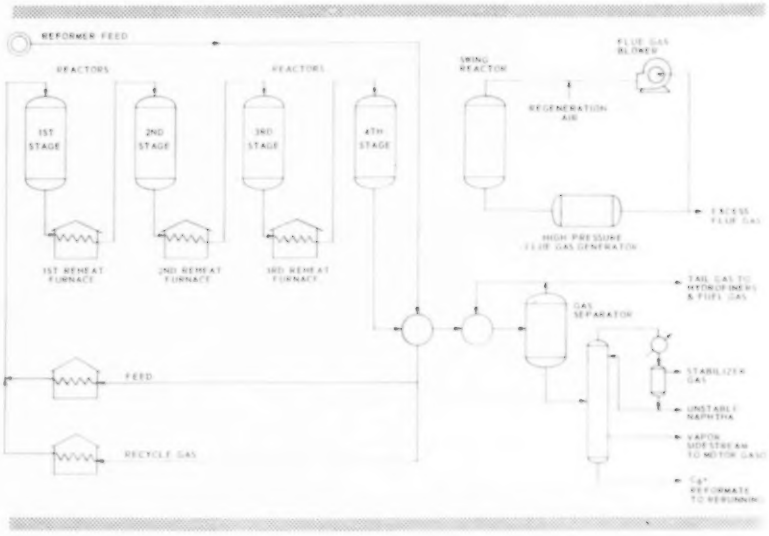


FIG. 1. Simplified flow diagram of Humble Oil and Refining Company's platinum-catalyst reforming units.

Feed-Stock Inspections

Feeds of three distinct boiling ranges are charged to the reformers in blocked operation. In this way, an optimum operating condition can be achieved for each feed. Table 1 presents typical

TABLE 1. Platinum-Reformer Feed Inspection.

Feed nominal boiling range, deg F	200 to 270	260 to 310	300 to 370
ASTM distillation, deg. F:			
Initial boiling point	210	272	306
5-percent point	213	275	310
10-percent point	216	277	312
20-percent point	218	279	314
30-percent point	220	280	316
40-percent point	222	281	318
50-percent point	224	282	321
60-percent point	228	283	324
70-percent point	232	285	328
80-percent point	236	287	333
90-percent point	245	290	341
95-percent point	253	295	349
Final boiling point	278	318	371
Gravity, deg API	56.9	51.6	47.3
Hydrocarbon type, percent by volume:			
Aromatics	10	16	19
Paraffins	42	41	39
Naphthenes	48	43	42
Olefins	0	0	0
Sulfur, ppm	72	105	125
ASTM octane number (D 908, Research Method):			
Without TEL addition	61.5	54.0	53.0
With addition of 3 ml TEL per gal	80.4	73.6	72.9
ASTM octane number (D 357, Motor Method):			
Without TEL addition	60.0	52.7	53.2
With addition of 3 ml TEL per gal	80.0	72.9	72.9

feed-stock inspections. Feed stocks are desulfurized and fractionated at another unit and are stored in intermediate tankage.

Product Yields and Inspections

Typical product yields for each type of feed are presented in Table 2. Inspections on the debutanized product are presented in Table 3. These data are presented at two levels of severity for each feed. It will be noted that the data are presented for severities of 93 and 97 octane number for the two lighter feeds and 90 and 93 octane number for the heaviest feed. Inasmuch as coke production increases as the boiling range of the feed increases, the heaviest feed is usually not reformed as severely as the light feeds. Maximum severity attempted to date was 100 octane number when the feed with a final boiling point of 270 F was charged. Stabilized reformate from this operation had a 103.8 Research octane number, with the addition of 3 ml TEL per gal.

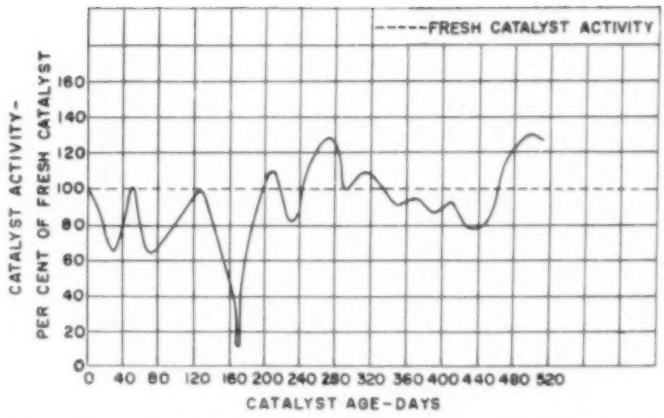


FIG. 2. Humble platinum reformer catalyst activity. Expected catalyst life is about two years. Feeds are normally reformed to about 93 RON, clear, although 100 RON, clear reformate has been produced.

Catalyst Deactivation

A platinum catalyst can be permanently poisoned by heavy metals such as molybdenum, arsenic, and lead. This is usually not a problem if the feeds are prepared as overhead distillates, as is now done by Humble. Careful sandblasting of the lines and equipment prevented molybdenum poisoning of the catalyst when the old molybdena reformer was converted for platinum. Sulfur is a temporary platinum-catalyst poison. In order to prevent this effect, the reformer feed stocks were originally desulfurized to less than 200 ppm of sulfur. Corrosion and scale considerations dictate a still lower sulfur level, as will be discussed later. Coke on the catalyst causes deactivation. However, the regeneration techniques employed by Humble have been very successful in burning off the coke from the catalyst, thereby restoring its activity.

Catalyst Activity

The activity maintenance of the catalyst used in Humble's platinum reformers has been exceptionally good. An average catalyst activity of 85 percent of fresh catalyst has been achieved since the startup of the units. On one occasion the activity of the catalyst declined to as low as 10 percent. However, regeneration techniques successfully restored the catalyst to the fresh level. This extreme decline in catalyst activity was caused by insufficient regeneration and scale, which had partially plugged the catalyst beds. A plot of the catalyst activity for the new unit is shown in Fig. 2. The catalyst in one reactor has now achieved a life of approximately 60 bbl of feed per lb of catalyst, with no indication of permanent activity decline. The oldest catalyst in the units has been on oil 450 days to date. An ultimate life of at least two years is now anticipated.

Regeneration

The platinum catalyst is reactivated by the process of regeneration. The reactor which is to be regenerated is re-

TABLE 2. Platinum-Reformer Product Yields.

Feed nominal boiling range, deg F	200 to 270				260 to 310				300 to 370			
C_5+ product octane number	93 Yield		97 Yield		93 Yield		97 Yield		90 Yield		93 Yield	
	C_5+ by Vol	C_5+ by Wt	C_5+ by Vol	C_5+ by Wt	C_5+ by Vol	C_5+ by Wt	C_5+ by Vol	C_5+ by Wt	C_5+ by Vol	C_5+ by Wt	C_5+ by Vol	C_5+ by Wt
Product:												
H_2		2.3		2.5		1.9		2.0		1.5		1.7
C_1		0.6		1.0		0.6		0.9		0.3		0.4
C_2		1.3		2.1		1.2		2.0		0.6		0.9
C_3		2.5		4.0		2.3		3.7		1.1		1.7
C_4	5.0	3.8	8.0	6.1	4.6	3.5	7.5	5.6	2.3	1.7	3.5	2.6
C_5	5.0	4.2	8.0	6.7	4.6	3.7	7.5	6.1	2.3	1.8	3.5	2.8
C_6+	80.8	85.3	73.4	77.6	82.0	86.8	74.7	79.7	88.4	93.0	84.9	89.9
		100.0		100.0		100.0		100.0		100.0		100.0

TABLE 3. Inspections on Debutanized Reformate.

Feed nominal boiling range, deg F	200 to 270		260 to 310		300 to 370	
ASTM octane number (D 908, Research Method):						
Without TEL addition	93.0	97.0	93.0	97.0	90.0	93.0
With addition of 3 ml TEL per gal	100.0	102.0	99.5	101.6	97.2	98.9
ASTM octane number (D 357, Motor Method):						
Without TEL addition	82.9	86.4	82.8	86.3	80.4	82.7
With addition of 3 ml TEL per gal	92.0	94.7	91.1	93.8	88.2	90.0
Gravity, deg API	45.8	44.4	43.0	40.7	41.3	40.5
Reid vapor pressure, psi	3.5	4.5	2.6	3.6	1.6	2.0
ASTM distillation, deg F:						
Initial boiling point	162	135	172	143	152	146
5-percent point	199	187	220	200	215	210
10-percent point	210	200	247	236	260	252
20-percent point	219	214	262	257	290	285
30-percent point	226	222	274	274	307	305
40-percent point	230	228	282	284	318	315
50-percent point	235	234	289	292	322	323
60-percent point	240	239	294	298	328	329
70-percent point	244	244	299	303	337	338
80-percent point	254	254	307	310	344	346
90-percent point	269	270	315	319	355	358
95-percent point	283	287	323	328	375	379
Final boiling point	313	325	358	383	426	432
Hydrocarbon type, percent by volume:						
Aromatics	59.5	65.0	59.9	70.6	55.5	62.0
Paraffins	37.0	33.0	36.5	26.0	34.5	31.5
Naphthenes	2.0	0.0	2.3	1.5	9.0	5.3
Olefins	1.5	2.0	1.3	1.9	1.0	1.2

placed in the reaction sequence by the swing reactor, it is purged of heavy hydrocarbons with recycle gas, and it then receives an inert-gas purge. After purging, a flue gas containing approximately two percent of oxygen is passed over the catalyst at a temperature between 800 F and 1050 F. When the coke burn is completed, the reactor is purged with inert flue gas, followed by a recycle-gas purge, and is placed back on reaction. The double block valve and seal-gas system is operated during regeneration, as previously discussed. Each reactor is regenerated at about six-day intervals. Generally, approximately 0.5 to 1.5 percent by weight of coke is burned during each regeneration.

Corrosion and Scale

Principal difficulties encountered in the operation of Humble's platinum reformers have been caused by sulfur and hydrogen sulfide corrosion of the hydrocarbon piping, which has resulted in metal loss and scale formation. Sulfur corrosion rates of 200 mils per year were experienced in the carbon-½ percent molybdenum tubes of the naphtha preheat furnace at the new reformer. This furnace has since been retubed with 9 percent chrome-1 percent molybdenum tubes. Hydrogen sulfide corrosion rates of approximately 60 to 90 mils per year have been experienced in the low-chrome molybdenum reheat tubes and transfer lines at this same unit. No corrosion was found in the 18 percent chrome-8 percent nickel tubes in the converted reformer. However, the same experience was obtained with low-chrome molybdenum metals as at the new unit.

In addition to the problem of metal loss, the scale flakes off the furnace tubes and transfer lines and plugs up the catalyst beds. The result is high-pressure drop and poor catalyst-bed distribution, which reduces the effectiveness of the catalyst. Because the reformers are equipped with double block valves, it has been possible to blind off a reactor, and to dump and screen the catalyst. The catalyst is reloaded, and activity is restored by regeneration. The permanent solution to the problem of corrosion and scale will be the installation of a hydro-desulfurization unit designed to reduce the sulfur levels of the reformer feed to less than 25 ppm.

Other Operating Problems

Among the other problems encountered in the operation of the reformers has been the coking of feed heat exchangers. This was caused by upset of the gas-blanketing system on the reformer feed tankage. The purpose of the gas blanket is to prevent oxygen from being absorbed into the feed. Dissolved oxygen can result in exchanger coking and fouling at the point in the system where the naphtha becomes entirely vaporized. Early in the operation of the units, catalyst attrition resulted from the high velocity of the vapor entering into the reactors. New reactor entrance baffles have eliminated this problem.

Conclusions

As a result of the highly successful operation of Humble's platinum reformers, it is concluded that fixed-bed, regenerative platinum-catalyst reforming is a logical choice as a means of providing the top-octane components necessary for the premium motor gasoline required today by modern automobiles. Because the catalyst can be regenerated, high-severity operations are possible while still maintaining long catalyst life and high product yields.

Reference

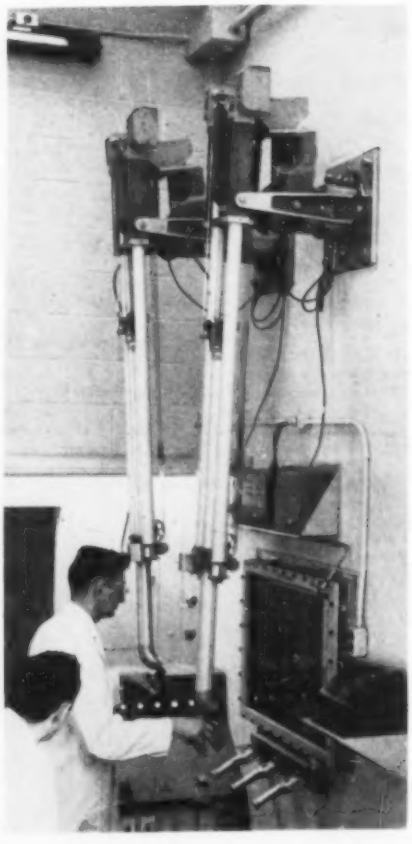
1. M. Sittig and W. Warren, "How to Get Those Top Octanes," *Pet. Refiner* 34 193 230-80, 1955.

★ ★ ★

The Author

The author received his BS degree in chemical engineering from the Virginia Polytechnic Institute in 1949. After graduation, he worked for about a year in an engineering training program with the U. S. Gypsum Company in their Sweetwater, Texas, plant. Next followed two years in the United States Army Chemical Corps as a chemical engineering research assistant in the Army's Specialists and Professional Personnel Program. Since his discharge from the Army, he has been employed by the Humble Oil and Refining Company in the Technical Service Division of their Baytown, Texas, refinery. He has been working directly with catalytic reforming for the past four years. For the last two years, his work has been concerned with Humble's two platinum catalyst reformers.

'Slave Hands' and 'Hot' Cobalt



Two technicians use master slave manipulators to handle radioactive cobalt 60 at the new Cranbury (N. J.) laboratory of Cities Service Research and Development Company. Six of these pieces of radioactive cobalt were moved to the Cranbury laboratories from the Atomic Energy Commission's Brookhaven National Laboratories at Upton, Long Island, May 1. The Cities Service shipment of 5000 curies is the most powerful yet to leave Brookhaven for industrial use. Each source is 13½ in. long by 2 in. wide by ⅛ in. thick and is contained in stainless steel. The 5000 curies in the shipment are more than twice as powerful as the total known supply of the world's radium.

P 937.0

Two years' service shows that

Phenolic Coating Eliminates Vessel Corrosion

Henry D. Schmidt
Design Engineer
Sinclair Refining Company

These copper chloride treating vessels at Sinclair's Houston refinery were coated with a modified phenolic resin two years ago for $2160, eliminating need for new alloy vessels or installation of alloy liners.

A change in operating conditions at a copper chloride vessel used for sweetening gasoline resulted in a dilute hydrochloric acid being formed. This condition resulted in such severe corrosion of the vessel bottom that the corrosion allowance of 1/8 in. was lost within eight months. It was therefore necessary to protect the vessel interior immediately to protect operations. The vessel is 9 ft in diameter, 25 ft in length, made of carbon steel, and set vertically.

Many types of coatings for the interior of the vessel were available but none of them had been field tested or subjected to actual operating conditions. No time was available for exhaustive tests to determine the relative merits of various coatings; therefore, attention was focused on the use of a material which had proved successful in a past application within the refinery. This application involved a blower handling sulfurous fumes from lubricating oil agitators. These fumes contained 10 percent SO_2 and SO_3, 70 percent air and 20 percent H_2O at a temperature of 125 F. Interior and exterior of the blower housing and the rotating element had been coated with a baked-on phenol-formaldehyde-resin coating and after five years continuous service, showed no signs of corrosive action. The carbon steel duct system, connected to the blower, had been painted internally with an acid resisting paint, but had corroded to such an extent that replacement was necessary.

Laboratory tests disclosed that a phenolic coating would withstand dilute hydrochloric acid at the operating temperature of 120 F. After discussing this problem with the applicator it was decided that favorable results could be obtained by lining the treating vessel with this phenolic coating, even though two conditions existed which were not present in the blower application.

First, since the interior surface of the vessel was severely pitted due to the corrosive action of the dilute HCl and a smooth surface was not available to receive the phenolic coating, it was necessary to apply a thick coating of the phenolic material modified with Epon.®

Secondly, the tower operation requires the addition or removal of Fullers Earth impregnated with copper chloride at frequent intervals. Mechanical impact blows from tools necessary to this operation can cause injury to the tower lining. This possible source of injury was considered in deciding on the phenolic coating as against a metallic lining, and it was felt that proper supervision during the recharging operation would reduce this hazard to a minimum.

Application of this coating demands specialized experience; therefore, an experienced applicator was chosen to do this work. First is the preparation of the metal surface followed by spraying and baking.

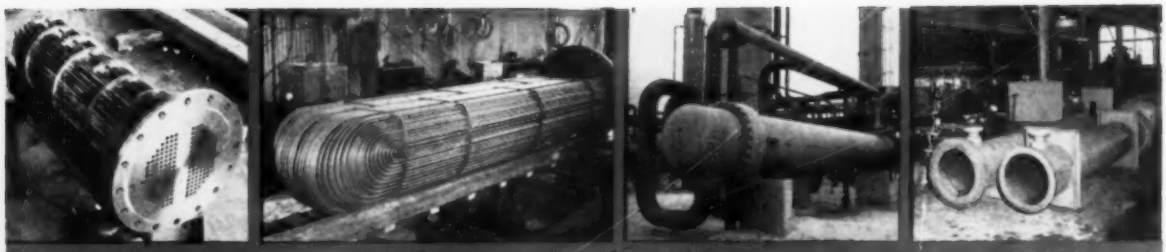
In preparing the metal surface all welds must be ground smooth, free from pin holes, undercutting and buckshot. All sharp edges should be radiused to 1/16-in. minimum. All surfaces to be coated must be sandblasted to white metal free from shadows. After blasting, the tank must be cleaned thoroughly.

Coating is applied in multiple coats by spray gun with intermediate or setup bakes at 250 F. During the coating process any additional metal imperfections must be filled, ground smooth or opened up to permit coating. Tank must be cleaned between coats to eliminate sand or dirt, carried or blown into the tank. Final high temperature bake is started after the coating has been built up to .005 to .007 in. and tested with a spark or holiday tester, (90-110 v). Final bake is held at 400 F until polymerization of the coating takes place. Normally to reach 400 F temporary insulation must be installed to permit even temperature distribution throughout the vessel. The finished coating will withstand a service temperature of 250 F. Baking is accomplished by using a gas burner mounted in a manhole. A total of 16 to 18 hours is required for all baking during the coating process.

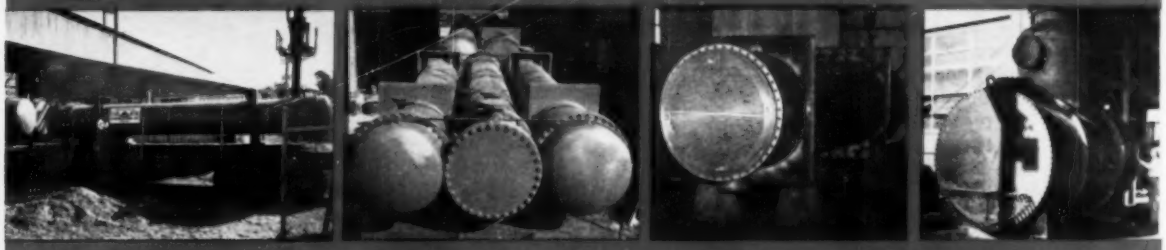
One vessel was coated inside in April 1955, and subsequent inspection revealed no corrosion taking place. A second vessel has since been coated and it also has shown similar favorable results. This baked-on modified phenolic coating has met expectations and has proved resistant to dilute hydrochloric acid in this particular treating operation.

The complete cost of this coating was $2160 or $2.61 per sq ft of interior surface. This includes the applicators contract price, scaffolding, pipefitting, cleanup labor, grinding internal welds smooth, compressed air, blasting sand, gas, and electricity.

A metal lining would have required alloy material at an installed cost of $8000 which added to the cost of the existing vessel gives $18,000 total. The modified phenolic lining cost $2160 installed which added to the cost of the existing vessel gives $12,160 total. A new alloy clad vessel would have cost $16,000. The modified phenolic lining, in addition to being lowest in cost, can be applied in the shortest time to a vessel already in service. In order to hold this favorable low cost position, however, the life of the coating must last for a period of at least five years. By careful supervision the lining has not been injured by impact blows from tools when changing impregnated earth in nearly two years of operation. ★ ★



Exchangers like these serve dependably throughout the industry.



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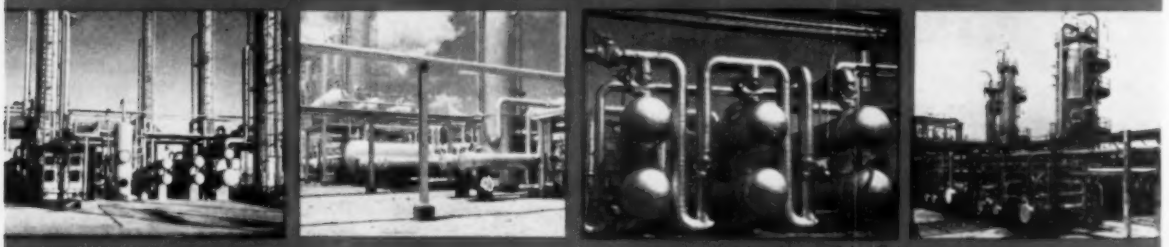
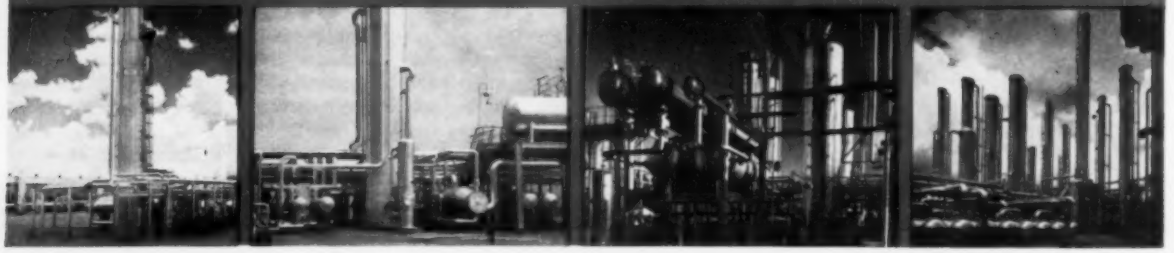


Major petro-chemical plants rely on superior equipment.



REGENERATION OF SPENT REAGENTS; Disposal of Refinery Wastes

Chapter 16

V. A. Kalichevsky
Consulting Chemical Engineer

PROBLEMS connected with the regeneration of spent reagents and the disposal of waste are not uniform at all refineries. They vary with the local conditions, processes employed and nature of the crude oil supply. What is permissible in a desert may not be tolerated in a city; a hydrogen fluoride alkylation plant has little in common with the plants using sulfuric acid; crude oils of high sulfur content must be handled differently from those of paraffinic nature.

The margin of profit derived from the refinery operations is continually narrowing. This forces the refiner to watch for all possible sources of income. Raw materials received by the plant must be fully utilized before they are discarded. The old wasteful practices were superseded by the modern thrifty technique.

Regeneration of Spent Reagents

Common treating agents that can be partially or completely regenerated include sulfuric acid, sodium hydroxide, clay and doctor solution. They are relatively inexpensive and were used by the industry for many years. Methods for revivifying and handling them were worked out by the plants on the basis of a long practical experience.

Chemical reagents employed by many modern refineries are of a different type. They are very effective but their cost is high. Their use can be justified if their consumption is reduced to a negligible quantity, that is to the mechanical losses which are kept at a minimum by using equipment of special design. Catalysts and solvents are among these treating agents. Their regeneration or recovery is an important part of each individual process and not a general refinery problem.

Sulfuric Acid Sludge

Spent sulfuric acid is a difficult material to dispose of both on account of its poisonous nature and the large quantities involved. Introduction of catalytic and solvent processes reduced the quantity of acid consumed in petroleum refining and lessened the importance of this problem. Another factor that came to the assistance of the refiner was the development of satisfactory methods for handling the acid sludge.

Sulfuric acid sludges are of two types: Fluid and non-fluid. Fluid sludges are obtained from treating light petroleum distillates, such as gasoline or kerosine, and a few other products, like paraffin wax and medicinal oils. Non-fluid sludges are obtained in refining lubricating oils. Sulfuric acid content of sludges may vary from 25 to 80 per cent. Whenever possible the fluid and the non-fluid sludges are blended in order to obtain a pumpable mixture that can be handled as a liquid.

In the past sludges were discharged into a neighboring stream or allowed to seep into the ground. This killed the plant and animal life or contaminated water in the wells which became unfit to drink and corroded the equipment. As the next step the sludge was diluted with water to reduce its acidity. Oil that separated was skimmed off and burned as fuel. This oil is toxic and its removal was a step toward the solution of the pollution problems. Spent caustic and lime were employed for neutralizing the acid layer but this was less satisfactory. Reaction products, sodium sulfate (Glauber's salt) and calcium sulfate (gypsum), are not harmful but phenolic substances were liberated by the spent caustic and poisoned the streams. Non-fluid sludges were burned occasionally by spreading them over a bed of coal in a furnace. These early methods of acid sludge disposal are still permissible in some localities but they are not universally applicable.

During the last decades several processes were developed for the recovery of sulfuric acid from the sludge. As a preliminary step, sludge is diluted with water for separating the oily constituents; mixture is heated with waste steam to speed up the separation. Pressure may be employed for heating the mixture to above the boiling point of water but not all the sludges respond equally well to this treatment. Sulfuric acid sludges are not uniform and adjustments in the procedure for handling them may be required.

Chemical reactions take place when water is added to the sludge. These reactions consist in the displacement of organic materials from their sulfuric acid compounds. This is known as "hydrolysis."

The oily layer recovered after the sludge hydrolysis is poured from the acid layer and used as fuel. The acid layer represents a dilute sulfuric acid which contains some of the organic matter that cannot be hydrolyzed by this process. This acid is concentrated by evaporating the water.

Evaporation of water requires heating. The quantity of heat needed for this purpose is considerable and increases with the volume of water added to the acid sludge. For economic reasons dilution with water must be controlled.

Two processes were developed for distilling water from the separated acid. The Simonson-Mantius Process uses vacuum. The Chemico Process distills water at atmospheric pressure with air bubbling through the acid. The use of vacuum or air is necessary to minimize foaming. Foam is caused by the organic matter present in the acid. This

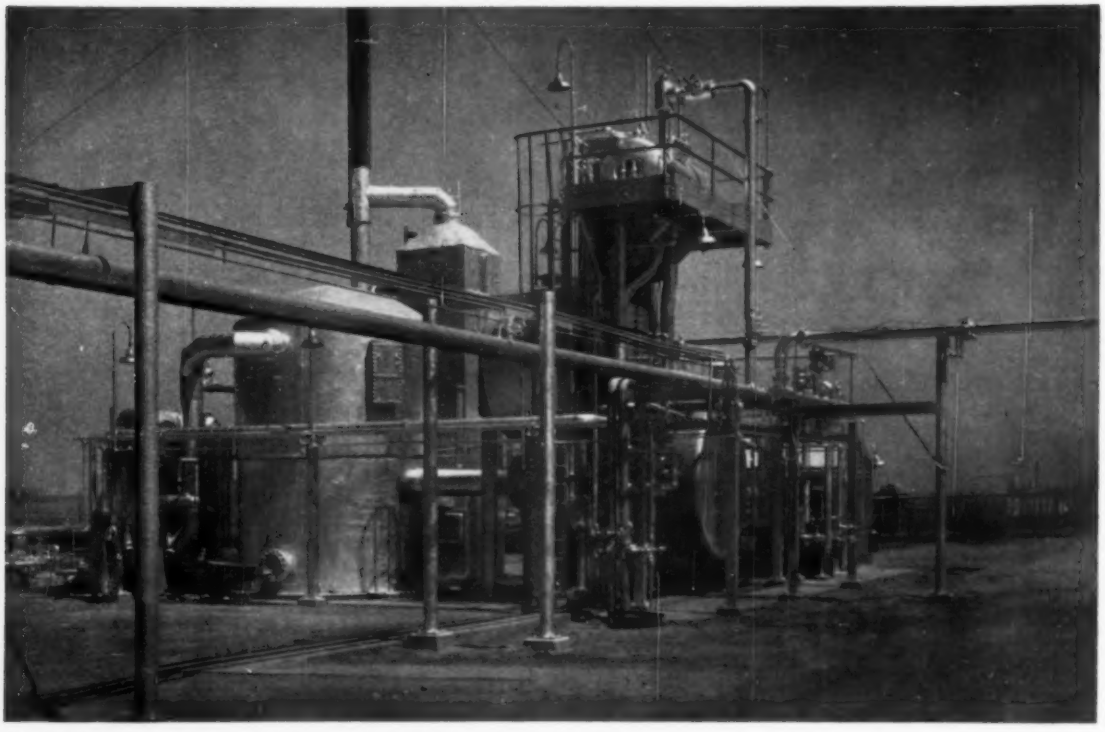


FIG. 1. Sulfur recovery unit in Texas, employed to recover an undesirable by-product from petroleum, and to add to the total refinery products made.

organic matter decomposes sulfuric acid into sulfur dioxide.

Acid is concentrated to 90-93 per cent strength. If concentration of the acid is continued by distilling off the water, the reaction between the acid and the dissolved organic matter becomes violent. As a result much acid is converted into sulfur dioxide and its yield is greatly reduced. Even under the most favorable conditions less than two thirds of the acid is recovered.

Recovered acid is fortified with fuming sulfuric acid to the desired strength. It is a very satisfactory treating agent and its efficiency is higher than that of fresh acid of equal sulfuric acid content. This happens because organic substances and not water make up the difference in the acid composition.

The Heckenbleikner Sludge Contact Process disposes of the necessity of concentrating the spent acid. Acid sludge is heated until all the sulfuric acid decomposes into sulfur dioxide. The sulfur dioxide is mixed with air and passed over a vanadium catalyst. The reaction which takes place at high temperatures produces sulfur trioxide:

$$\underset{\text{Sulfur dioxide}}{SO_2} + \underset{\text{Oxygen}}{O} = \underset{\text{Sulfur trioxide}}{SO_3}$$

Sulfur trioxide is sulfuric acid with all the water removed. By adding water to sulfur trioxide sulfuric acid of any strength can be obtained:

$$\underset{\text{Sulfur trioxide}}{SO_3} + \underset{\text{Water}}{H_2O} = \underset{\text{Sulfuric acid}}{H_2SO_4}$$

Recovery of sulfuric acid from the sludge is economical if the quantity of the sludge is appreciable. For this reason some of the refineries are selling their sludge to the chemical companies that do the processing. Spent sulfuric acid can also be utilized in the manufacture of certain chemicals, for instance ammonium sulfate, a well-known fertilizer. Several petroleum companies are engaged in its manufacture. This is a convenient method of solving the acid sludge and sulfur disposal problems.

Ammonia and sulfuric acid are the basic materials needed for the manufacture of ammonium sulfate. Ammonia is obtained by passing nitrogen and hydrogen over a catalyst at a high temperature and under pressure. Nitrogen is obtained from the air and hydrogen is available at some refineries:

$$\underset{\text{Nitrogen}}{N_2} + \underset{\text{Hydrogen}}{3H_2} = \underset{\text{Ammonia}}{2NH_3}$$

Ammonia thus produced is reacted with sulfuric acid yielding ammonium sulfate:

$$\underset{\text{Ammonia}}{2NH_3} + \underset{\text{Sulfuric acid}}{H_2SO_4} = \underset{\text{Ammonium sulfate}}{(NH_4)_2SO_4}$$

Burning of the oil separated from the sulfuric acid sludge is a common refinery practice. This oil is very rich in organic compounds of sulfuric acid which produce large quantities of sulfur dioxide on heating. Separated oil can be burned directly but it is usually diluted with fuel oil to reduce the percentage of sulfur dioxide in the flue gases. Furnaces for burning such fuels must be made from acid-resistant bricks. High stack temperatures must be maintained to prevent condensation of moisture which intensifies the action of sulfur dioxide.

Caustic Solutions

At first sodium hydroxide solutions were disposed of in the manner similar to that described in connection with sulfuric acid. They were discharged into the neighboring streams. This procedure was abandoned when it was found that these solutions were even more toxic than the acid. Then the solutions were stored in ponds before they were discharged. During this storage the solutions absorbed car-

bon dioxide from the air and sodium carbonate was formed. Toxicity of spent caustic was considerably reduced before it left the refinery.

Attempts were made to regenerate the spent sodium hydroxide solutions by using the commercial process for manufacturing sodium hydroxide. Spent solutions were saturated with carbon dioxide from flue gases. This produced sodium carbonate (washing soda). The oil layer containing phenolic substances was separated and used as fuel. Lime was added to the water solution of sodium carbonate to convert it to sodium hydroxide:

Na_2CO_3	+	$Ca(OH)_2$	=	$CaCO_3$	+	$2NaOH$
Sodium carbonate		Lime		Calcium carbonate		Sodium hydroxide

Calcium carbonate is insoluble in water and separated as a precipitate.

This process was not a commercial success because the spent sodium hydroxide solution contained impurities and the quantities handled were comparatively small making the process expensive.

Caustic is not a cheap reagent. On weight basis sodium hydroxide is two and a half times and potassium hydroxide is four times more expensive than sulfuric acid. For this reason the refiner utilizes the caustic solutions to the fullest extent before discarding. Regeneration of caustic solutions in the modern treating process became very attractive to the refiner.

Caustic solutions found considerable application in the removal of mercaptans from light petroleum distillates. In the modern processes, the spent solutions are regenerated by blowing with steam or air. Steam displaces mercaptans from their solutions in caustic because the acidity of mercaptans is very low and the compounds they form with caustic are unstable. Air oxidizes the mercaptans into disulfides as it was described in Chapter 13 (The Refining Engineer, December, 1956, C-24). Disulfides are insoluble in water and form an oily layer which is separated from the regenerated sodium hydroxide solution. These disulfides find only a few commercial applications and are often burned.

Sodium and potassium hydroxide solutions used in the mercaptan removal processes can be employed for several months before they lose their activity. This is caused by the accumulation of hydrogen sulfide and carbon dioxide that cannot be driven out with steam or air. These partially spent caustic solutions are used for absorbing hydrogen sulfide from the petroleum distillates until they contain no free caustic. Such solutions are rich in sulfur compounds and find a market in the paper and other industries.

Caustic solutions containing appreciable quantities of phenolic substances extracted from the light petroleum distillates are used in the manufacture of by-products. These phenolic substances are largely phenol and cresols which are valuable chemicals. They were formerly produced only by the coal tar industry but demand exceeded the supply.

Phenols are recovered by adding acid to the spent caustic solutions. Carbon dioxide present in the flue gases is satisfactory for this purpose. Acid can be added in steps to obtain phenols and other organic acids in fractions of progressively higher acidity. The mixture of phenol, cresols and similar substances obtained from the spent caustic is separated by distillation.

Clay

Spent clay is washed with naphtha and steamed for removing the oil it may hold, and is harmless. The quantity of clay used by some refiners is appreciable and difficulties may be encountered in its disposal. Two types of clay are employed for refining petroleum: Fine contact clays and course percolation clays. Problems involved in the regeneration of these clays are different.

Finely divided clays are difficult to regenerate. No cheap method has yet been discovered for restoring their original decolorizing efficiency. Partial revivification is not satisfactory because the quantity of clay needed for decolorizing the oil increases with the decrease in clay efficiency. This overloads the filters and reduces the plant throughput. For the same reason the use of the expensive, highly efficient clays is more economical than the use of cheap clays.

Contact clays cannot be regenerated by burning in the present commercial equipment. Heat destroys their fine structure and they lose their decolorizing power. Some of these clays lose their original activity at temperatures below those at which the oil will burn. As contact clays are expensive, a considerable amount of work was done on the methods of their revivification. Among these methods the use of solvents offers the greatest possibility.

Mixtures of solvents, like benzol and acetone, restore the decolorizing efficiency of clay by loosening and dissolving the absorbed organic matter. However, large quantities of solvents are lost in processing and the cost of regeneration is high. For this reason the contact clays are discarded after use.

Percolation clays are regenerated by burning. This explains the existence of percolation plants which are more expensive to build than the contact plants. Percolation clays are cheaper than the contact clays which is also in favor of the process. These two methods are in competition with each other.

Percolation clays are of two varieties: Fullers' earth and bauxite. Fullers' earth is more sensitive to heat than bauxite. It can be regenerated in the laboratory without an apparent loss in efficiency but in commercial kilns its activity falls down gradually, thus limiting the number of times it can be revivified.

The difficulty of regenerating clay in commercial kilns is their inability to maintain a uniform burning temperature. Uneven distribution of heat is due to the uneven distribution of the adsorbed oily matter on the spent clay and of the air needed for combustion. Oil begins to burn at a reasonable rate at a temperature not less than 1000F. However, fullers' earth begins to lose its activity when it is heated above 1100F. For this reason commercial kilns are operated at an average temperature of 1050F, but the temperature fluctuations within the kiln are much greater than ±50F. This means that local overheating cannot be avoided. As a result the clay loses gradually its activity and must be discarded after 5 to 10 regenerations. The number of burnings to which the clay should be subjected is an economic problem for each plant to solve.

Bauxite can withstand considerably higher burning temperatures than fullers' earth without losing its activity. By taking a few precautions, decolorizing properties of bauxite can be maintained at a very high level after many regenerations. For this reason bauxite is not discarded. A small quantity of fresh bauxite is added from time to time to the bauxite recycled through the plant to make up for the mechanical losses. These losses should be less than two per cent per cycle. Addition of fresh bauxite to compensate for these losses assists in keeping up the decolorizing efficiency of the plant bauxite.

Bauxite is about twice as heavy as fullers' earth. It is more expensive and less efficient on the weight basis than fullers' earth, but its ability to withstand regenerations explains its use by many refineries.

Clays discarded by the refineries are in limited demand by other industries. They are used in the manufacture of building materials, like cinder bricks, or employed as fillers. High transportation costs confines their market to local consumption.

Doctor Solution

Doctor solution is an expensive refinery reagent. In addition to sodium hydroxide it contains litharge which is four times more expensive than sodium hydroxide and 16 times more expensive than sulfuric acid on weight basis. In addition the lead atom is very heavy and this means that much more lead is needed for combining with other chemicals than sodium. If this correction is made, the cost of litharge is 60 times that of sulfuric acid. This explains the importance attached to the regeneration of doctor solutions.

Lead oxide changes into lead sulfide when gasoline is sweetened. The lead sulfide formed is oxidized back to lead oxide by blowing with air as it was briefly mentioned in Chapter 13. This reaction proceeds in steps. When lead sulfide is oxidized in caustic solution, lead sulfate is formed:

PbS	+	$2O_2$	=	$PbSO_4$
Lead sulfide		Oxygen		Lead sulfate

Lead sulfate is dissolved by sodium hydroxide with the formation of sodium plumbite and sodium sulfate:

$PbSO_4$	+	$4NaOH$	=	Na_2PbO_2	+	Na_2SO_4	+	$2H_2O$
Lead sulfate		Sodium hydroxide		Lead plumbite		Sodium sulfate		Water

Sodium sulfate is an inert substance in the sweetening reaction and sodium hydroxide consumed in forming it is lost to the process. As a result the quantity of free sodium hydroxide in the doctor solution is reduced after each regeneration. The number of times the doctor solution can be regenerated depends on the original concentration of caustic and the quantity of caustic added for fortifying the solution. This cannot be done indefinitely and the solution must be finally renewed. Expensive lead is saved by using the following procedure.

The exhausted doctor solution is employed for absorbing hydrogen sulfide from the refinery gases until all the lead precipitates and the free sodium hydroxide still present in the solution is converted into sodium sulfide. Lead sulfide is separated from the solution and saved. The spent solution is disposed of in the manner previously mentioned. Fresh caustic solution is added to the lead sulfide and the mixture is blown with air until sodium plumbite is formed.

Retrieving Wasted Oil

A complete balance between the materials entering and leaving a plant is an impossibility on account of mechanical losses. These losses are sometimes divided into avoidable and unavoidable losses. Avoidable losses are due to poor housekeeping, to the absence of proper equipment for reducing evaporation of light petroleum fractions and slopage. Unavoidable losses include the oil lost in cleaning tanks, in draining the equipment before a shut down, in leaky heat exchangers and condensers, and in leaky pipes. Theoretically all losses are avoidable and in practice they can be kept very low if supervision is adequate.

The quantity of oil lost by a refinery can be very large. One big refinery had an underground leak of such a magnitude that an enterprising person built a small refinery next to it for the recovery of the oil seeping in his direction. Such happenings can be avoided by eliminating as far as possible the underground pipes, periodically testing all the pipes for leakage and making weight balances, that is measuring the quantities of materials in and out, around the refinery and individual units.

Oil lost by surface leaks finds its way eventually into the refinery sewage unless it is volatile. Refinery sewage is essentially waste water carrying oil in emulsion. It has no connection to sanitary sewage. By providing proper facilities the oil can be recovered. Large refineries may collect a thousand or more barrels per day and add them to their crude oil supply. Recovery of this oil is also important for preventing pollution of the surrounding territory.

Oil is recovered by passing the waste refinery water through separators before it is discharged into a stream. Separators are big ponds where the water is kept for several days before it is released. The ponds may be operated in parallel or in series.

Separators work automatically. Floats are used for controlling the oil and water levels. Rate of flow is regulated to provide the necessary settling time for the oil to collect on the top. This oil is skimmed off and pumped to storage.

Separation of oil from the refinery sewage usually proceeds without difficulty but emulsions may form. They are broken by the methods described in connection with crude oil emulsions. Waste steam may be used for heating these emulsions and reduce their stability. Addition of a small quantity of chemicals, like sodium carbonate, is often sufficient to destroy them. Waste water originating from different refinery units may be segregated to facilitate its handling and reduce the emulsion forming tendencies.

Water leaving the settling ponds might contain small quantities of oil. If this happens, the oil is removed by passing the water through "hay filters." Although hay is an excellent filtering medium, it is expensive and seldom used. Straw, excelsior, spent clay, and ground coke are cheaper and quite satisfactory for clarifying the water. When purification is complete, the water discharged by the refinery may be cleaner than the intake from the stream. This occurs if the refinery consumes considerable quantities of purified water or of water obtained from the underground wells.

Water Pollution

Polution of water by a modern refinery is a rare occurrence. It might happen by accident, such as a flood or a big fire, but the possibility for these disasters is remote. A system of dams around large storage tanks and the sewage facilities are safeguards from minor accidents. In most instances, complaints brought up against the refineries can be traced to entirely different causes and the municipal sewers are liable to be the real offenders. One of the reasons why the refineries are blamed sometimes for negligence is the ease with which traces of oil floating on the water surface can be discovered. A thin film of oil is not necessarily harmful and may be the result of somebody else's negligence.

A film of oil 0.0000015-in. thick is visible on the water surface. This quantity is very difficult to visualize. It is in the region of the wave-length of light and molecular dimensions. Two thirds of a million of such films must be piled on top of each other to reach the thickness of an inch. Twenty-five barrels of oil spread over a surface of one square mile are sufficient to form such a film.

Oil floating on the surface prevents air from penetrating into the water. Fish and other aquatic life need oxygen to survive and a thick film of oil may cause damage. However, oil films considerably thicker than the one described disappear quickly if the water is slightly agitated which is normal in nature. Before the purified water leaves the refinery it is aerated, that is oxygen is dissolved in it by contacting water with air, in order to make it healthy.

Chemicals poison fish. Fish can stand small quantities of acid better than caustic, but acid destroys valuable bacteria on which the life of the fish depends. For this reason the refinery liquid waste is neutralized and discharged containing only harmless salts in solution.

Phenolic compounds, ammonia, chlorine, and some other organic and inorganic substances may be deadly in small concentrations but the possibility of their presence in refinery waste in measurable quantities is remote.

Recovery of Refinery Vapors and Gases

Substances released by a refinery to the atmosphere may include light hydrocarbon vapors, sulfur dioxide and other refinery gases containing sulfur and phenolic compounds, and flue gases from the stacks. Fatty acids used in grease manufacture, such as fish oil, may produce disagreeable but harmless odors. Asphalt plants evolve unpleasant fumes on blowing residuum with air. Many of these materials are of considerable monetary value and a refinery cannot afford to waste them.

Methods for the recovery of hydrocarbon vapors will be covered in a forthcoming chapter on transportation and storage. These vapors must be saved because they are the expensive portions of gasoline. Their recovery is a routine refinery practice.

Sulfuric dioxide is obtained on burning fuels containing sulfur compounds. It is also produced in sulfuric acid treatment because of decomposition of the acid. Small quantities of sulfur trioxide may be evolved when fuming sulfuric acid is used. Sulfuric compounds that impart a disagreeable odor to gases are destroyed. Such gases are passed through stacks. These convert the sulfur, nitrogen and oxygen compounds having an offensive odor to flue gases.

Hydrogen sulfide is present in many refinery gases. It is poisonous. Old methods for removing it consisted of absorbing hydrogen sulfide in caustic solutions. This is expensive and seldom used now, except for washing gasoline and other liquid refinery distillates containing this gas. Modern methods scrub gases containing hydrogen sulfide with chemicals that are revivified by blowing with steam and applying heat. These chemicals, like those used in the Dualayer and Solutizer processes, for the removal of mercaptans, extract hydrogen sulfide very efficiently under one set of conditions and release it under another set of conditions.

In the Girbotol Process, Fig. 2, the gases are contacted with the water solutions of ethanolamines. These are organic liquids related to ammonia but having a very high boiling point. Spent ethanolamine solutions from the absorber are heated and passed to the reactivator where hydrogen sulfide is removed by blowing with steam. The regenerated solution is recycled to the absorber.

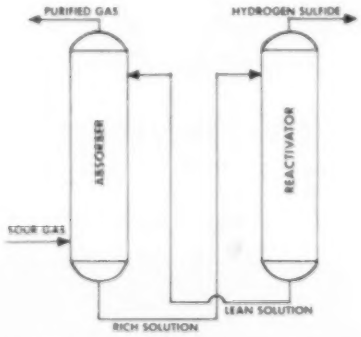


FIG. 2. Simplified flow chart of the Girbotol Sulfur Removal Process.

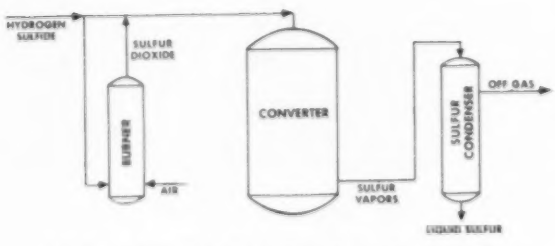


FIG. 3. Flow chart of Modified Claus Sulfur Recovery Process.

In the Shell Phosphate Process the solution of potassium triphosphate is employed. It is also regenerated by heating and blowing with steam. In this process the presence of carbon dioxide, which is a comparatively strong acid, does not interfere with the hydrogen sulfide removal.

Other processes for the removal of hydrogen sulfide were developed. In the Seaboard Process soda ash is used and the spent solution is revivified by blowing with air. In the Thylox Process, arsenic trioxide in soda ash solution is employed. Glycol-Amine Gas Treating Process is used for removing hydrogen sulfide and water vapors from natural gas. Carbon dioxide is obtained as a separate stream. The solution used for absorbing these gases contains diethylene glycol in addition to ethanolamine. Drying of natural gas transported under high pressure is important because under certain pressure and temperature conditions gases, like methane, form solid compounds with water which plug the pipes.

The above processes separate hydrogen sulfide from the gases in a highly concentrated form. This makes the recovery of sulfur from hydrogen sulfide a paying proposition. The Claus Process originally developed by the soda ash industry and modified to meet the conditions encountered in the petroleum industry is used for this purpose. One third of hydrogen sulfide is burnt to sulfur dioxide as shown in Fig. 3. The quantity of air is adjusted so as to avoid excessive dilution. Reaction is speeded up by the presence of alumina catalyst. Iron oxide was used in the original Claus process:

$$\underset{\text{Hydrogen sulfide}}{H_2S} + \underset{\text{Oxygen}}{1\tfrac{1}{2}O_2} = \underset{\text{Sulfur dioxide}}{SO_2} + \underset{\text{Water}}{H_2O}$$

The resulting gases are mixed with the remainder of hydrogen sulfide in the presence of boiling water. This produces elementary sulfur:

$$\underset{\text{Hydrogen sulfide}}{2H_2S} + \underset{\text{Sulfur dioxide}}{SO_2} = \underset{\text{Sulfur}}{3S} + \underset{\text{Water}}{H_2O}$$

Hydrocarbon gases also can be treated for hydrogen sulfide removal by selectively oxidizing hydrogen sulfide with air in the presence of clay catalyst:

$$\underset{\text{Hydrogen sulfide}}{H_2S} + \underset{\text{Oxygen}}{0} = \underset{\text{Sulfur}}{S} + \underset{\text{Water}}{H_2O}$$

Air Pollution

Air pollution has received much attention recently, particularly in Southern California. Trash burners, millions of cars on the road, unrestricted burning of saw dust in lumber producing regions on the Pacific Coast suffocate the inhabitants of California, Oregon, and Washington. Contrary to common sense, politicians attempt to ascribe the resulting smog to petroleum refineries.

High stacks dissipate sulfur dioxide released by the refineries into the air. It is of interest that this gas is beneficial to plant and animal life when present in small concentrations, well above those the refineries emit. Although sulfur dioxide is not causing smog in California, some refineries use fog sprays containing water or a three per cent solution of sodium carbonate for deodorizing the gases and foul air. Smoke is not evolved from the refinery stacks. It is caused by incomplete combustion and cannot be tolerated for economic reasons.

REFINING IN BRIEF

Automotive Fuel Pumps— Their Performance

R. A. Randall
General Motors Research Staff

ALTHOUGH the presently used diaphragm-type fuel pump remains attractive for economic, engineering, and durability reasons, its continued use is being challenged by current trends in automotive and fuel designs. Specifically, these trends are (1) higher underhood temperatures resulting from the wide demand for air conditioning and newer body styling, and (2) incorporation of the more volatile components of petroleum into gasoline. As a result, the pump is required to handle a larger volume of vapor while it supplies the given weight of fuel required by the engine. Whenever the pump fails to handle this vapor and does not deliver the required fuel, the engine is starved for fuel and vapor lock occurs.

Studies were made of diaphragm-type fuel pump performance using a bench system designed to duplicate a vehicle fuel system. Heat was applied to the fuel by passing hot water through a hose jacketing the fuel line and the carburetor was modified to provide flow control. Fuel weight flow was determined by measuring weight change of a fuel supply can.

Fuel pump diaphragm movement was followed by means of strain-gage instrumentation along with suitable electronics to calibrate the signal in terms of diaphragm position. Instantaneous pressure fluctuations in the fuel pump cavity were detected by means of a condenser-type pressure pick-up. Outputs of these detectors were displayed simultaneously on an oscilloscope.

Estimation of Pump Stroke

The relationship between the amount of stroke taken by the pump diaphragm and pressure fluctuations in the pump cavity is important in the understanding of basic pump action.[1] In order to study further this relationship, simultaneous diaphragm movement and cavity-pressure fluctuations of the type shown in Fig. 1 were recorded. A volatile fuel was being pumped when this photograph was taken and it may be seen that the pressure reached a minimum before the diaphragm reached the bottom of its stroke.

From the pressure trace it would be estimated that the pump was taking 48 percent of full stroke. The diaphragm actually was moving through 92 percent of full stroke, however. It may be concluded that as a result of the phase shift, the pump stroke cannot be estimated from the cavity-pressure fluctuations.

Studies were made in an effort to determine the reasons for the phase shift in Fig. 1. This phase shift has been explained qualitatively on the basis of pressure drop and restriction effects. Pressure drop across the inlet valve tends to make the minimum pressure occur at the maximum diaphragm velocity, while restrictions in the inlet line tend to make the pump behave as a closed system and tend to move the minimum pressure to the bottom of the stroke.

V/L Determination

Because hot fuel handling ability is allied with the capabilities of the pump to handle large amounts of vapor along with the liquid gasoline, the volume ratio of vapor to liquid (V/L) is useful in studying the mechanism of vapor lock. A unique feature of this work was the determination of vapor-to-liquid ratios from measurements of diaphragm movements within the pump itself. These diaphragm movements, together with the weight of fuel pumped, permitted the calculation of V/L's at various operating conditions both on the bench set-up and in a vehicle.

Using any one fuel on the bench set-up it was possible to obtain various V/L's and hence various weight-flow rates by varying the temperature of the water in the jacketing line. Results of V/L calculations for one fuel pump cover at four cam speeds are presented in Fig. 2. The fuel-flow rate as a percentage of the engine full-throttle fuel requirement at the corresponding cam speed is plotted as a function of the V/L. The point 100 percent full-throttle fuel requirement (100 percent FTFR) has been defined as "vapor lock" because the fuel flow is just able to satisfy the engine full-throttle demand and theoretically any less flow will give vapor lock. The V/L values at "vapor lock" read off this figure and similar figures for three other pump covers are listed in Table 1.

Overall, the limiting V/L values range from 22 to 44.5. A minimum appears to be reached at about 1200

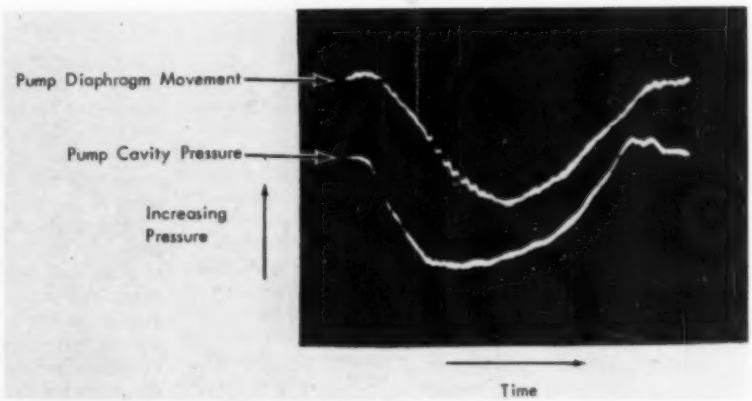
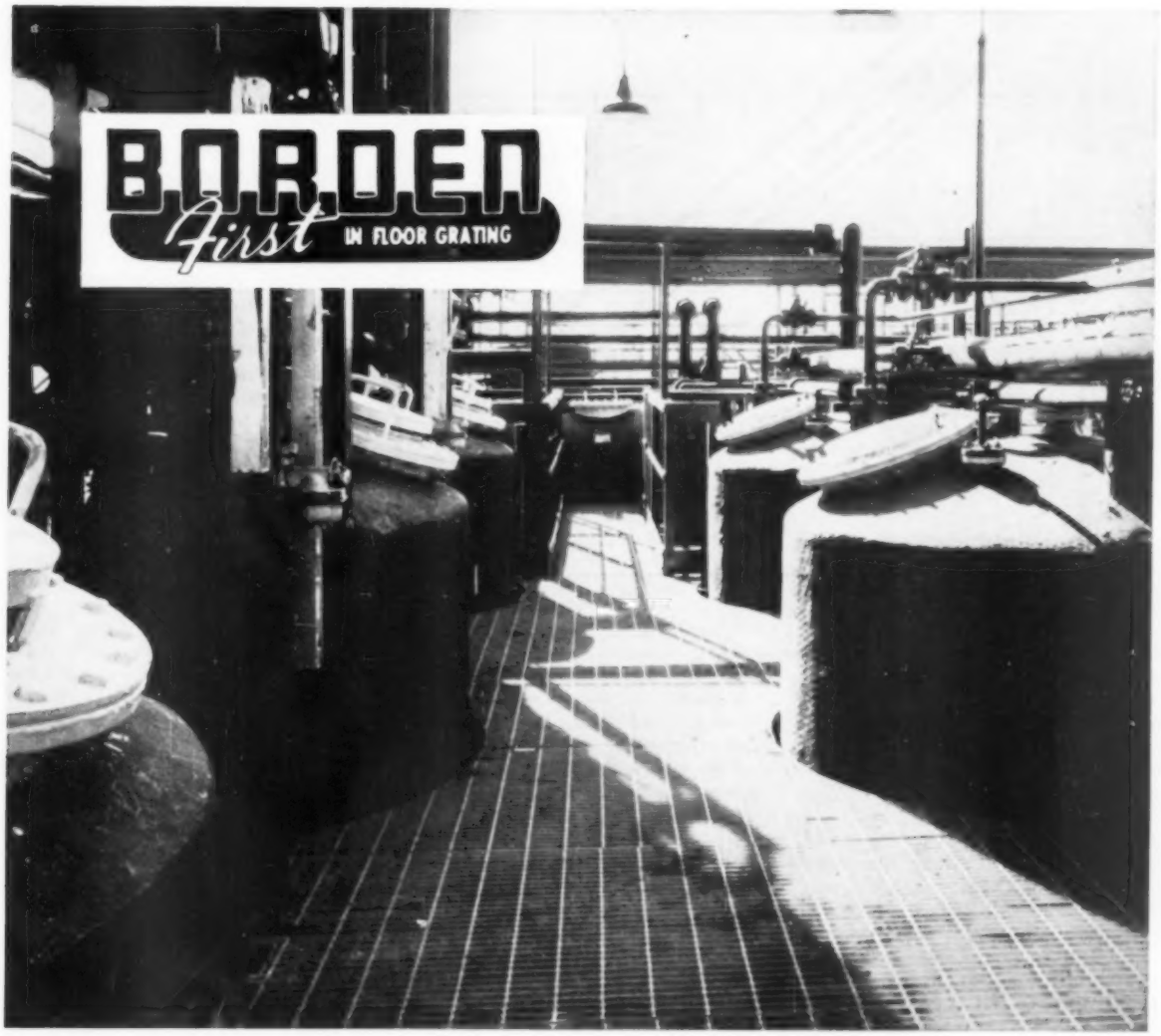


FIG. 1. Pump diaphragm movement and cavity pressure fluctuations with a volatile liquid being pumped.

Condensed by the author from a paper presented before the Society of Automotive Engineers, June 1956.



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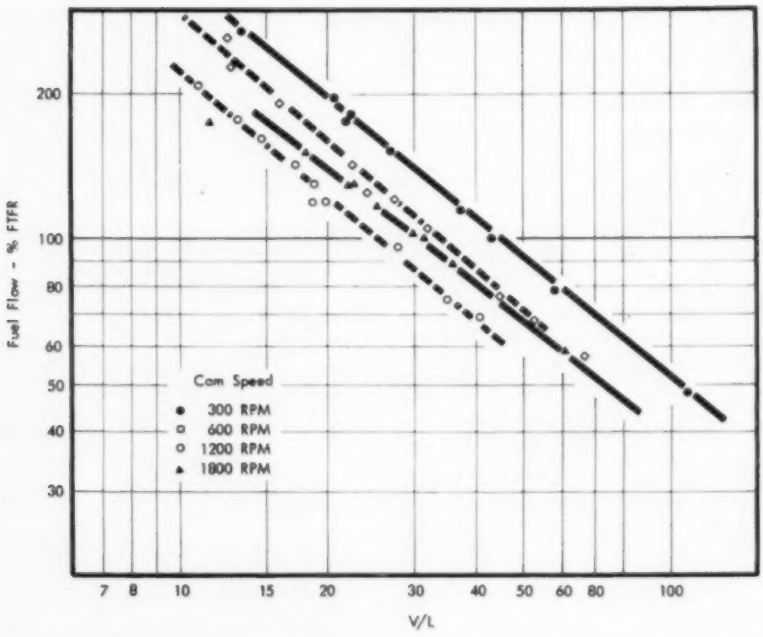


FIG. 2. Fuel flow (percent full throttle fuel requirement) as a function of vapor-to-liquid ratio (V/L) pump cover A on a bench setup.

TABLE 1. V/L at "Vapor Lock" on Bench Set-Up.

Pump Cover	V/L at "Vapor Lock"			
Cam speed—rpm	300	600	1200	1800
A	44.5	33.5	26.2	30.5
B	38	31	23.5	27
C	37.5	31	23	26
D	37.5	29	22	25

rpm when the V/L's at 100 percent FTFR range from 22 to 26.

The question then to be answered is, "does this information apply to a full scale vehicle?" Accordingly, similar instrumentation was installed on a vehicle with a similar type of fuel system. The vehicle was operated on a chassis dynamometer in a wind tunnel at an ambient temperature of 100 F. The V/L at vapor lock on the vehicle with pump cover A was 36 at 600 rpm cam speed, and was 29 at 1200 rpm cam speed. It may be seen that the vehicle and bench data are in excellent agreement.

It is interesting to compare these measured V/L values determined on a bench and on a vehicle with other reported values. Heath, Thena and Way[2] give a "limiting V/L ratio of 26, believed to be representative of a large part of the vehicle population."

Effects of Fuel-System Variables on V/L

On the bench set-up the V/L at "vapor lock" was affected by restrictions in the outlet line. As the outlet line restriction was increased, the V/L at "vapor lock" was decreased.

Vapor-handling capacity (the V/L at vapor lock) was increased by running the pump at a higher speed. For example, if the pump was run at engine speed rather than cam speed, the V/L could be increased from 34 to 64 at vapor lock. Of course, while the vapor-handling capacity is increased by running the pump at a higher speed, the vapor-forming tendency of the system may be changed, probably towards increased vapor-forming tendency. Furthermore, the carburetor may not be able to handle the higher V/L resulting at the increased pump speed. When the relationship between the fuel-system vapor-handling capacity and vapor-forming tendency are fully understood and the results applied to the improvement of fuel pump design, the full potential of the diaphragm pump may be achieved.

References

1. Caplan, J. D., and Wilson, R. E., "Characteristics of Fuel Pump Operation During Vapor Lock," SAE Preprint, SAE Summer Meeting, June 6-11, 1954.
2. Heath, D. P., Thena, R. H., and Way, G., "Passenger Car Vapor Lock," SAE Preprint, SAE Golden Anniversary Annual Meeting, January 10-14, 1955.

REFINING IN BRIEF

P 937.0

How Atlantic Refining Company Developed and Uses . . .

Maintenance Cost Controls

Edmund C. Newton
The Atlantic Refining Company, Philadelphia, Pennsylvania

MAXIMUM utilization of refinery equipment is attained only through the concerted efforts of many groups. Included are process, research, engineering, inspection, maintenance, and all service groups. The following is an account of the contribution of one of these organizations to the joint venture.

The mechanical (maintenance) department's standardized craft methods and related engineered job times, together with the wholehearted co-operation of process and service groups, are proving extremely effective in work planning and manpower scheduling at the Philadelphia refinery of The Atlantic Refining Company. These factors are materially improving manpower utilization and reducing work costs. This is particularly evidenced by reductions in refinery unit turnaround

Condensed by the author from a paper presented at the Plant Maintenance and Engineering Conference, January 1957, Cleveland, Ohio.

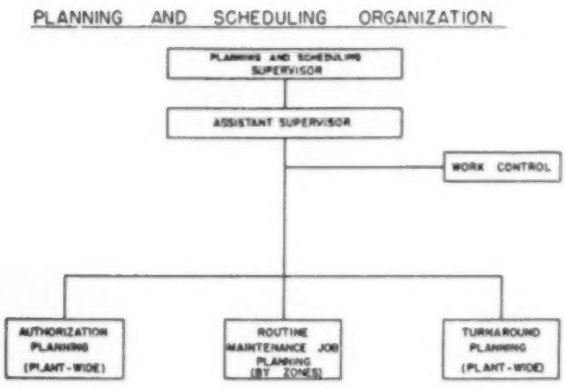


Figure 1.

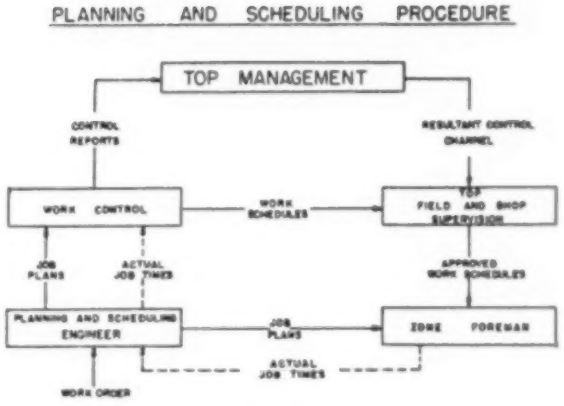


Figure 2.

manpower requirements and in the manpower needed for daily maintenance. As a result a larger portion of mechanical craft manpower is utilized on capital work.

Initial Developments

In 1950 a program was begun with the ultimate purpose of setting up a system for manning jobs in the most adequate yet most economical way possible. From its inception this program progressed along several essential lines; namely, standardization of work methods for all major mechanical crafts, training of supervisors and craftsmen in these techniques, development of related engineered planning times, improvement in the planning and scheduling organization and system, and packaging of larger elements of repetitive work including unit turnarounds.

Standardization of Work Methods

Experience has taught us that an accurate detailed evaluation of work to be done is impossible when different methods are used to perform the same type of work. Therefore, in order to isolate units of work and provide a common yardstick for measuring extent of work, the most effective method of doing specific craft operations was established and documented. This phase was accomplished through the close cooperation of an industrial engineer and one or more of the most experienced foremen in each specific craft. All such work was done under the guidance of a thoroughly indoctrinated development engineer of the mechanical department. The methods were compiled into volumes called *Standard Practice Instruction Manuals* (SPI's) and copyrighted. To date SPI's have been developed for the field crafts of welding, pipefitting, carpentry, rigging, exchanger repair, boilermaking, pipecovering, painting, and field machinist.

Training of Supervisors and Craftsmen

Upon completion of the SPI's first line supervisors (job foremen) were trained in the content and usage of the manuals. The training sessions were designed to aid the foremen in understanding the different craft methods and to acquaint them with the sources of needed information.

SPI's also were used as the basis for the upgrading and improvement training of craftsmen. After determining training needs through means of craft surveys, the methods contained in the SPI's were adapted to field and classroom training sessions. Within a two-year period all second class mechanics who wanted training and who could meet course requirements were graduated as first class craftsmen. Future needs for first class mechanics will be filled by processing helpers through the SPI based training programs.

Development of Engineered Planning Times

Engineered planning times (EPT'S) were established for the standardized craft work methods developed for specific jobs. These times were developed on the basis of all recorded data available and, also, the experience of key first-line supervisors. Again, an industrial engineer worked with the designated supervisors under the guidance of the development engineer. Engi-

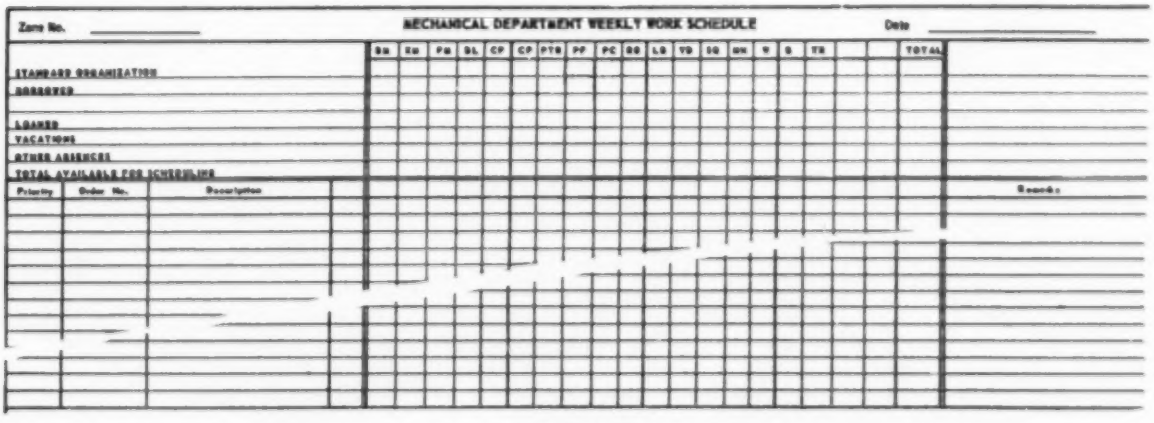
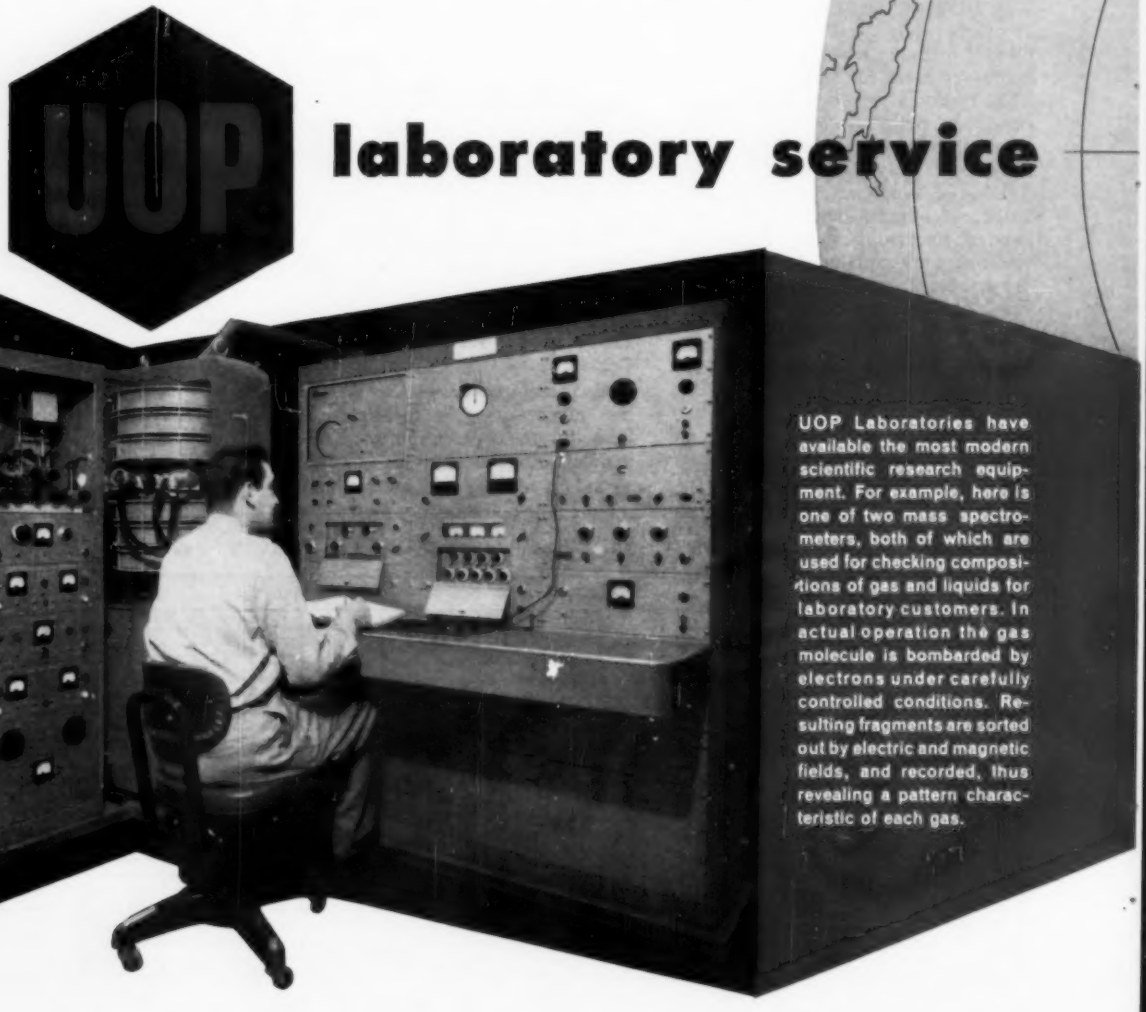


Figure 3.

Refining and research go together. The laboratory is vital to the successful operation of any oil refinery. That's why refiners, everywhere, have come to depend on UOP for many essential laboratory functions.

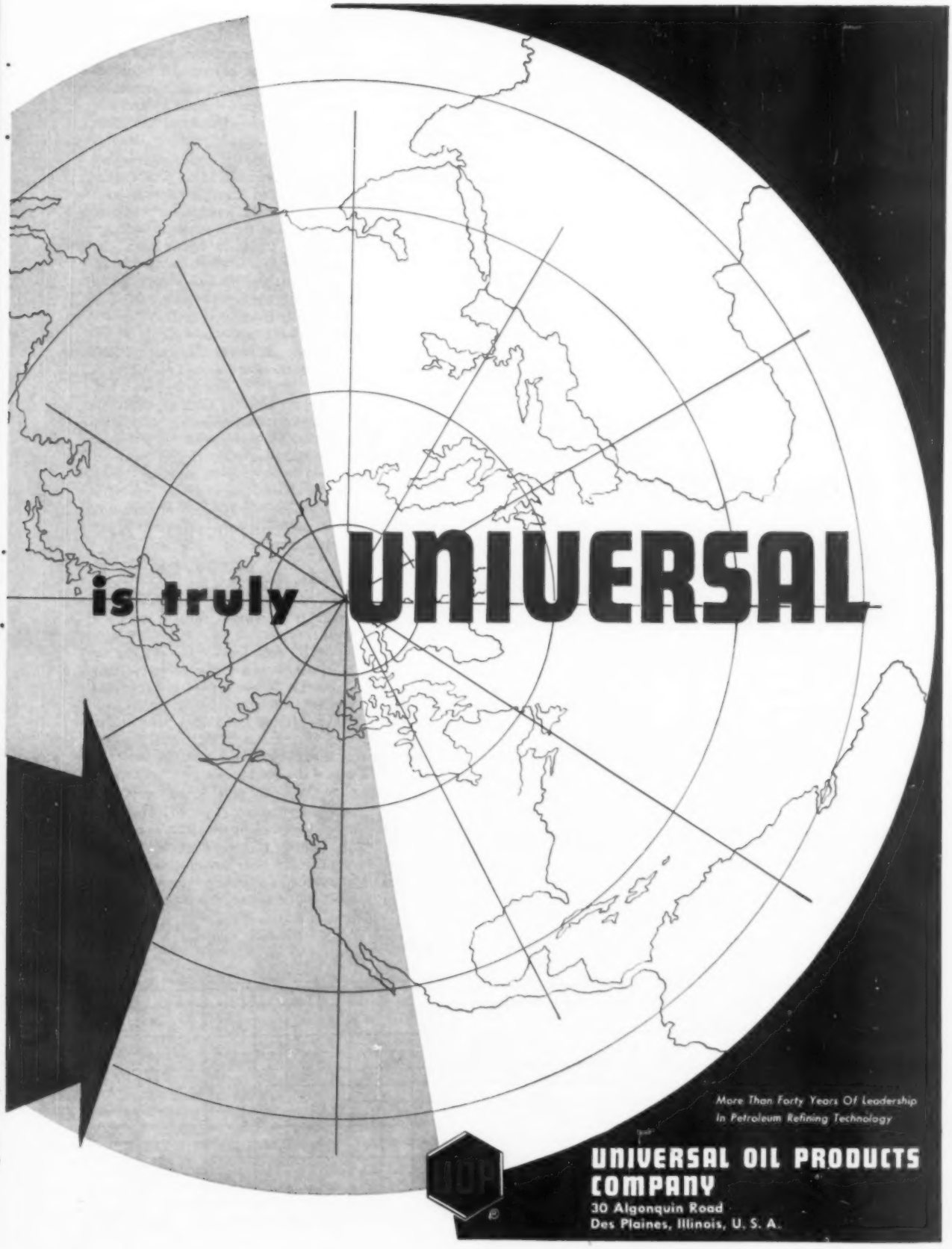
UOP laboratory service is broad, comprehensive, expert, providing vital information that in most cases would be impractical or economically impossible for the individual refiner to develop. It covers such specifics as the evaluation of crudes, problems of treating products for maximum stability, maintenance of product quality, performance of gas concentration equipment, answers all the requirements of a thorough and complete laboratory service.

Today, refiners everywhere in the free world are users of this laboratory service. It is available to any refiner, regardless of his volume or scope of operation. UOP laboratory service is truly universal.



UOP laboratory service

UOP Laboratories have available the most modern scientific research equipment. For example, here is one of two mass spectrometers, both of which are used for checking compositions of gas and liquids for laboratory customers. In actual operation the gas molecule is bombarded by electrons under carefully controlled conditions. Resulting fragments are sorted out by electric and magnetic fields, and recorded, thus revealing a pattern characteristic of each gas.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MECHANICAL DEPARTMENT
WEEKLY REPORT OF FIELD SECTION OPERATIONS

WEEK OF _____

SCHEDULED VS ACTUAL MANNING

MON. THRU. FRI.		SCHEDULED PER DAY	ACTUAL PER DAY
MAIN AUTH.	CAP		
	EXP		
TANK AUTH.	CAP		
	EXP		
TOTAL AUTH.	CAP		
	EXP		
SHUTDOWNS			
FIXED MAINT.			
MOVABLE MAINT.			
AVAILS			
LOANS			
VACATIONS			
ABSENCES			
STD. ORG. INCLUDING ____ TRAINEES.			
SAT.			
SUN.			

MANPOWER UTILIZATION

CLOSED JOBS ONLY	NO. JOBS	MANDAYS P	MANDAYS A	P/A %
AUTH.				
S.O.				
J.O.				
M.O.				
TOTAL				

CONTROL PLANNED AUTH.	NO. JOBS	MANDAYS P	MANDAYS A	CURRENT P/A

NET AUTHORIZATION RECEIPT RATE
± MANDAYS / DAY

BACKLOG CHANGES SUMMARY

		TOTAL MD	NO. JOBS
CAPITAL AUTH.	MAIN		
	TANK		
	TOTAL		
EXPENSE AUTH	MAIN		
	TANK		
	TOTAL		
SHUTDOWNS 12 MONTHS			
J. O.			
M. O.			
TANK PAINTING			
TOTAL BACKLOG			
UNAUTHORIZED			

BACKLOG SUMMARY BY CRAFTS

FORECAST ORG. AVAILS	BM	XR	FN	BL	CF	C	PTR	PF	PC	RG		YD	SQ	W	B	TOTAL
AUTHORIZATIONS																
SHUTDOWNS																
MAINTENANCE																
TOTAL BACKLOG																
DAYS OF WORK																

Figure 4.

neered times for key jobs were field tested in actual productive operations before being released for field planning use.

Improvement in Planning and Scheduling

While work methods were being standardized and engineered planning times established, the planning and scheduling organization was tailored to make the most effective use of such data in planning and scheduling maintenance and construction work. The present organization, as shown in Fig. 1, is staffed to perform the following activities:

a. To develop and plan routine maintenance jobs in the various plant zones.

b. To develop, plan and follow up all unit turnarounds.

c. To develop, plan and follow up all authorization work. (These authorizations include construction work and larger elements of nonrepetitive maintenance work.)

d. To maintain work control through compiling information and scheduling manpower.

In a general way the planning and scheduling procedure for work orders is illustrated in Fig. 2. Work orders received from various sources are routed through the planning and scheduling engineer. He, in close co-operation with the maintenance zone foreman and the order originator, checks each order, determines when completion of the work is required, notes safety precautions, etc. He then plans the job according to SPI methods and EPT's, prepares charts and sketches, and orders special materials as needed. This engineer has the responsibility for the overall planning of the job, and he submits the fully developed plan to the zone foreman who has the responsibility for getting the work done. It should be pointed out that in the interest of economy if a job involves five mandays or less of work a guided estimate, based on past performances, is made instead of a detailed evaluation of the extent of the work. This latter practice is currently under scrutiny in an effort to improve specific work knowledge and utilization of manpower.

A copy of the developed plan is sent to the work control group where similar information from all zones is compiled. All field manpower is then scheduled for the following week according to a priority listing set up by top management. This schedule is reviewed by top field and shop supervision, adjusted as necessary, and distributed by them to their line supervisors for work performance.

As jobs are worked, the actual time spent on them are routed to the work control group where they are compared with planned time to determine manpower utilization data. Information compiled by this group is forwarded to top management personnel, who are then in a position to exert any guidance or control that might be necessary.

Following are typical examples of some of the reports prepared by the work control group:

a. Weekly Work Schedule (Fig. 3). This report, which is prepared for each zone, indicates the total number of men available for work during the week and their distribution by type of work. Types of work include top priority authorizations, unit shutdowns (turnarounds), permanent assignments, special maintenance jobs (listed individually), and small daily maintenance jobs (listed as a group). Men assigned to this last type are used for emergencies if the need arises.

b. Weekly Scheduled vs Actual Manning Report (Fig. 4). This summary report compares, by type of work, the number of men scheduled with the number of men actually used during the preceding week. A more detailed report (not shown) presents the same in-

MECHANICAL DEPARTMENT CRAFT BACKLOG REPORT

ZONE NO. _____ ORDER TYPE _____ PRIORITY _____ PREPARED BY _____ DATE _____ PAGE ____

DESCRIPTION AND PRIORITY NO.	DATE OR CODE	NO. OF JOBS	BM	XR	FN	BL	CF	CP	PTR	PF	PC	RG	LB	YD	SQ	SM	W	B	FIELD TOTAL MAN DAYS	ML	SHOP	DEPT. TOTAL MAN DAYS

Figure 5.

formation for individual top priority jobs.

c. Weekly Field Manpower Utilization Report (Fig. 4). A summary report indicating actual effectiveness (planned vs actual manning) for all jobs closed during the previous week. (Job and mechanical orders are orders covering different types of routine maintenance work). This same information for each specific job closed is contained in a more detailed report (not shown).

d. Craft Backlog Report (Fig. 5). A compilation, by craft, of the total number of mandays of work which the mechanical department is expected to do in the future. The previous week's backlog and the net change during the week of the report are also included.

Packaging Larger Work Elements

We have learned from experience that planning costs can be reduced by planning larger elements of repetitive work on an EPT package basis. Such elements include unit turnarounds, routine compressor work, tank building and repair, pipe installation, tank painting, etc.

All pieces of an element to be packaged are first EPT evaluated to determine the size of the job. Then the total work load is programmed with respect to most effective gang sizes in order to set up the daily manning and determine the duration of the work. It should be pointed out that provision is made for work additions or deletions while the job is in progress.

Once the job has started the following data are recorded daily on the package plan sheet:

1. Actual manpower expended.
2. Mandays of work completed each shift.
3. Percent of total work completed to date.
4. Percent of total work that should be completed to date to finish on schedule.
5. Actual manpower used expressed as a percent of total manpower planned.
6. Number of mandays ahead or behind schedule.

This information is reviewed daily so that manpower can be shifted as necessary to fit the work load. Manpower is not put on jobs until the work is ready and is removed as rapidly as jobs are finished.

One of the foremost advantages of the packaged plan is that when a complete unit is EPT consolidated the basic plan can be reused with a minimum of effort. Elements of work can be added or deleted as conditions warrant. Such a feature is particularly advantageous in event of an emergency or unanticipated shut down of a unit.

Our experience with packaged shut downs has not been extensive. However, the results obtained thus far have been very gratifying and represent a reduction in manpower requirements for unit turnarounds of 25 percent under previous experience. On the basis of such results, all additional major units have been packaged for future turnaround operations.

Cooperation

In conclusion, it should be emphasized that any system of standardized work planning, be it the best system on record, cannot produce the desired results without the complete cooperation of all parties involved. The unlimited cooperation of process operators, inspectors, safety personnel, all staff and service groups, and mechanical personnel working together is making a significant contribution toward the goal of improved manpower utilization and reduced work costs.

P 720.31

Developing Engineers in Refining Technology

D. S. Simmons

General Manager, Manufacturing
Imperial Oil Ltd.

SINCE 1947 Imperial Oil Ltd. has given, at Sarnia, intensive nine-week refining technology courses to a total of 100 refinery engineers from across Canada. These courses came about through the following considerations:

1. After World War II the company's refineries were old and out of date. The company was therefore faced with a heavy capital outlay, commencing in 1946, for modernization of seven refineries. (Since that time two new refineries have been added.) Refinery engineering personnel had to be trained to build, operate, and maintain the modern units.
2. In view of the wartime emergencies the refinery staffs had remained static in both personnel and training. New engineers were not easily obtained and transfers, unless absolutely necessary, were frowned upon.
3. Our engineering data was largely contained in the "Blue Book" which had a very limited circulation, and this circulation was even more restricted in the case of refinery engineers.

For these reasons, then, Imperial brought together 16 men in the fall of 1947 to give them some of the — until then—closely guarded data which they needed to operate efficiently. Each presentation of the course since then has required extensive revision. The course given last fall was as follows:

This is an abstract of a paper presented before the American Petroleum Institute's Division of Refining, May 17, 1956.

PROGRAM OF SUBJECTS
Sixth Petroleum Refining Course

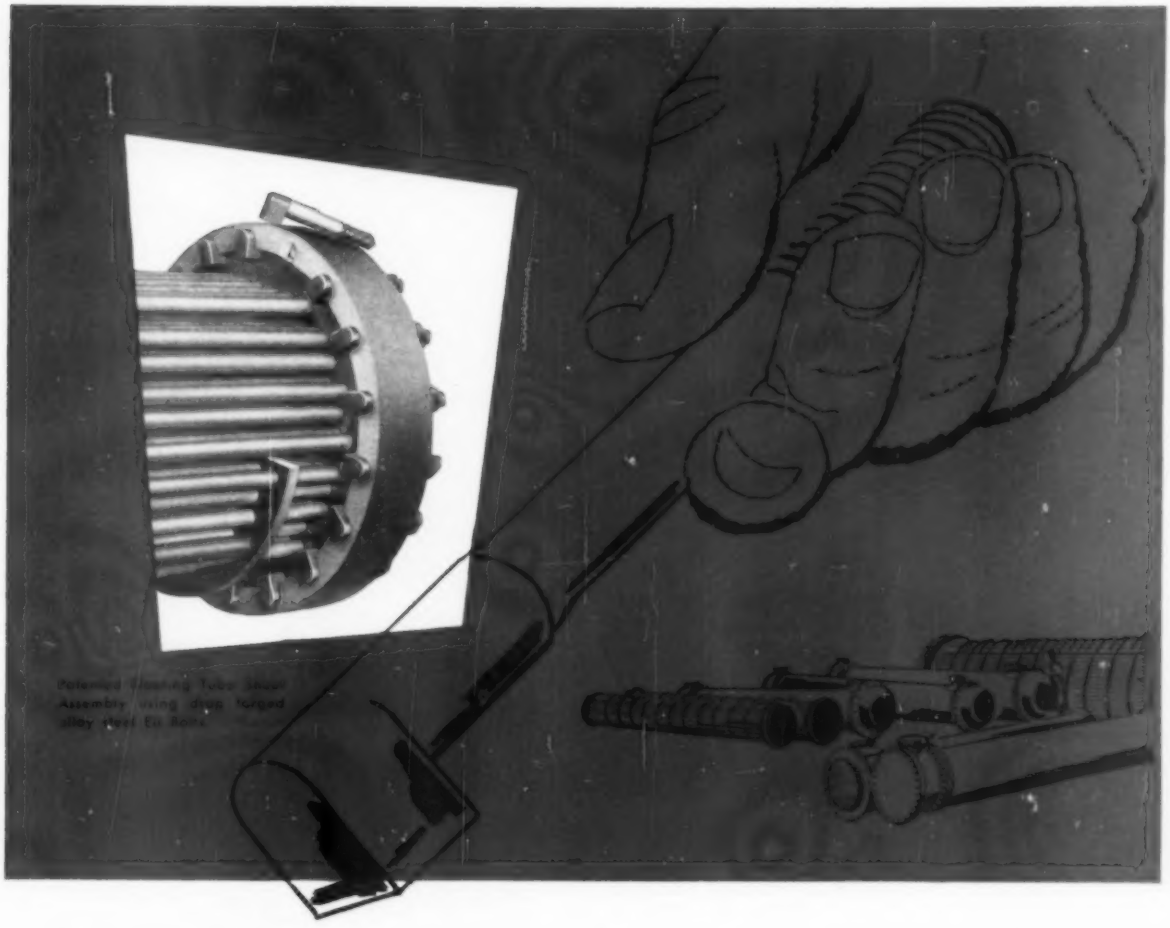
Sarnia

Manufacturing Department

1. Physical Chemistry and Use of Esso Blue Book — 3½ days
   - (a) Stoichiometry
   - (b) Properties of gases
   - (c) Properties of liquids
   - (d) Viscosity
   - (e) Thermal properties
2. Electronic Computer (IBM-CPC) — 1½ days
   - (a) Description
   - (b) Coding
   - (c) Simple operations
3. Flow of Fluids — 2 days
   - (a) Types of Flow
   - (b) Friction Factor
   - (c) Measurement of Flow
   - (d) Pressure drop
   - (e) Line Sizing
4. Fluid Mixing — ½ day
5. Corrosion — ½ day
   - (a) Types
   - (b) Prevention
6. Heat Transfer — 7 days
   - (a) Types
   - (b) Heat transfer coefficients
   - (c) Design of exchangers
     - I — Liquid-liquid
     - II — Condensers
     - III — Reboilers
     - IV — Tank heaters
     - V — Extended-surface exchangers
7. Distillation — 12 days
   - (a) Fundamental theory
   - (b) X-Y Diagram
   - (c) Flash curves
   - (d) Debutanizer design
     - I — Lewis and Matheson method
     - II — Esso Research and Engineering method
   - (e) Pipe still design
   - (f) Vacuum tower design
   - (g) Pumparound streams
   - (h) Fractionating tower design practices
   - (i) Drum design practices
8. Absorption and Stripping — 5 days
   - (a) Fundamentals
   - (b) Kremser-Brown method
   - (c) Sherwood graphical method
   - (d) Horton-Franklin method
   - (e) Edminster method
9. Combustion and Furnace Design —2 days
   - (a) Fundamentals
   - (b) Burners
   - (c) Fuels
   - (d) Furnace design
10. Pumps — 1 day
    - (a) Types
    - (b) Seals
    - (c) Characteristic curves for centrifugals
    - (d) NPSH
    - (e) Pump Specifications
11. Centrifugal Gas Compressors — 1 day
    - (a) Description
    - (b) Compressor calculations
12. Treating and Desalting — 1-hour discussion of notes
13. Waste Disposal and Losses — 1-hour discussion of notes
14. Utilities — 1-hour discussion of notes
15. Economics, Costs and Budget — 1-hour discussion of notes
16. Instruments — ½ day
    - (a) Flow meters
    - (b) Automatic control
    - (c) Control valves
    - (d) Automation
17. Catalytic Cracking — 2 days
    - (a) Definitions
    - (b) Catalyst flow
    - (c) Aeration
    - (d) Regeneration and stripping
    - (e) Types of units
    - (f) Operating variables
18. Hydroforming — 1 day
    - (a) Fundamental theory
    - (b) Types of units
    - (c) Catalysts
    - (d) Operation
19. Fluid Coking — 1½ day
    - (a) Types of coking processes
    - (b) Jersey's fluid cokers
    - (c) Operating problems
    - (d) Coke disposal
20. Polymerization and Alkylation — ½ day
    - (a) Fundamental theory
    - (b) Types of processes
    - (c) Catalysts
    - (d) Operating problems

A program of this kind cost a lot of money, and the nine weeks spent by the men on the course is not the most of it. Revision of course material, and the study necessary to write up the latest developments in techniques take time. Considerable time is needed by instructors preparing their lectures and this has to be done at the expense of other productive work they may be doing. The company feels that this expense is justified since under normal conditions the operating engineers do not have adequate opportunity to learn the background of engineering design and theory in their day-to-day jobs. Having had such background, the operating engineers are able to perform their work more efficiently and thereby justify the expense. It should be noted that a course of this type needs constant revision to maintain its effectiveness.

In the first course tests were used to check the absorption of the course content. However, we have since eliminated these tests and find that most course participants realize that their future depends on their ability to apply modern technology to their jobs. These men, living and working together as a group, gain an understanding of the company's problems and generally undertake the hard work and homework necessary to take full advantage of the course. The objective of the course is to provide opportunities for the trainees to test their engineering assumptions and judgment. A further objective is to more clearly integrate the work of the engineering division with the technical staffs of the refineries. The course appears to be the best method for meeting these objectives. This course, we believe, helps to raise the refinery engineer's sights beyond the routinely technical. ★ ★ ★



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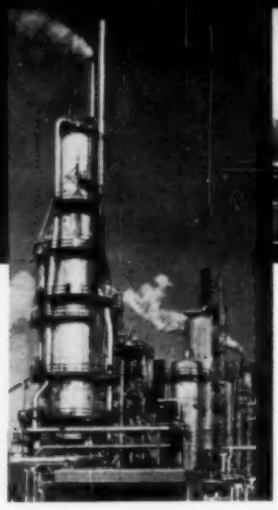

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HOW TO "BOX IN" LEAKY FLANGES

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Series 15 flanges (3 in.) have only four bolts, have caused us the most trouble as far as leaks are concerned. If enough pressure was applied in the right places, these four-bolt flanges could be eliminated, at least from process units. During the Petroleum Session of the Plant Maintenance and Engineering Show in Cleveland last January, all agreed that these flanges should be eliminated from critical places; other refiners have shared our experience.

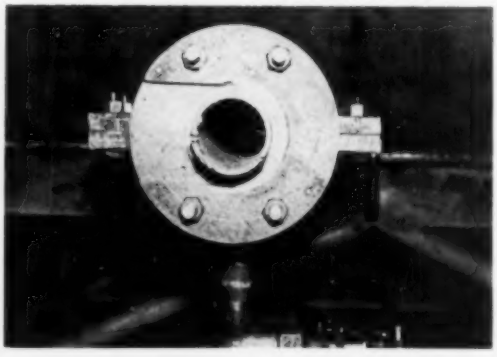
The split repair box provides a good answer, albeit temporary. The repair box actually has six main parts: The body, which is made in two pieces including the packing gland, and the two packing glands which are also split into two pieces each. As shown in the photos, the four bolts that pull the packing gland in also hold the two pieces together. However, the glands are dowelled 180 deg apart to insure an accurate fit. The two main body parts are likewise dowelled.

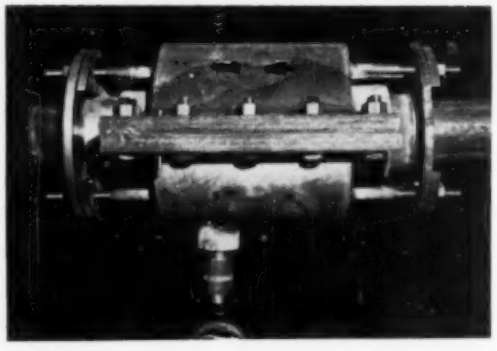
After welding is finished on the body and glands, machinists put the finishing dimensions on with a shaper and a lathe. The packing glands and joint on the main body are machined to 0.004 tolerance. The full facing allows us to use a full face gasket on the main body, usually made from a high-grade asbestos gasket material.

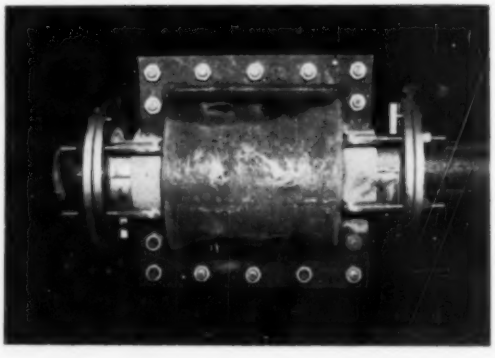
A 1½-in. connection is usually put on the bottom of the box to vent off leaking liquid or gas until the installation is completed.

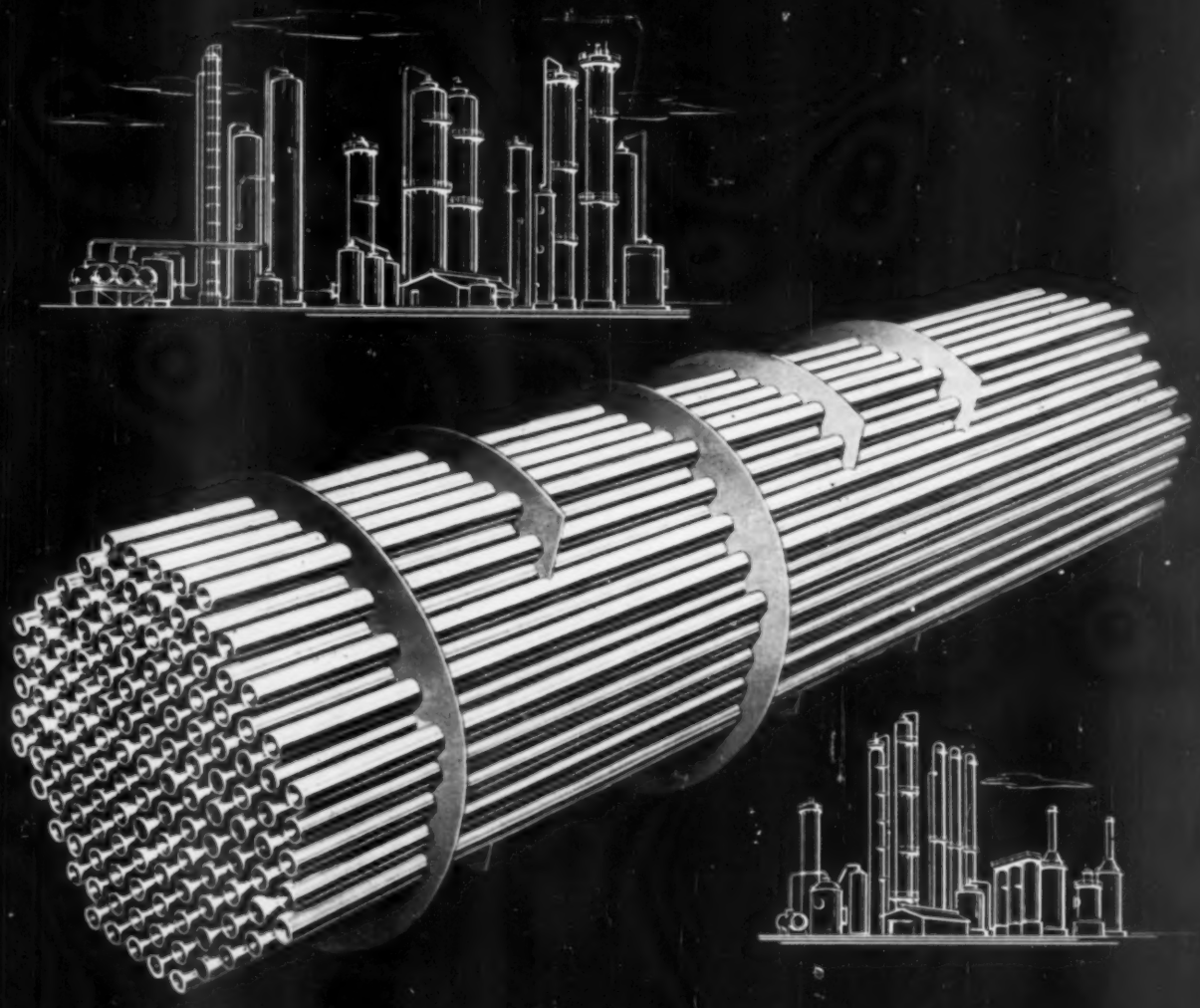
Bert E. Newton
Chief Planner
The Ohio Oil Company
Robinson, Illinois

Ed. Note. Mr. Newton says that you shouldn't hesitate to contact him if you'd like to have more information.









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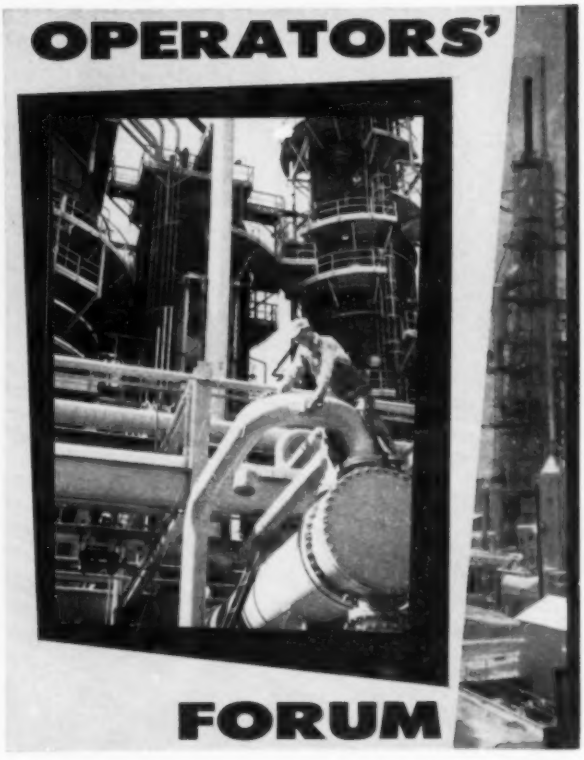

Q **Our refinery is presently planning to move three 80 ft diameter, 30 ft high tanks approximately 300 ft by floating them. Consequently, we are interested in the techniques used, especially with regard to internal bracing, which we assume is necessary to keep the tanks rigid during the floating operation.**

B. F. D.

How to Move Tanks by Floating

A The Bayway refinery of the Esso Standard Oil Company, Linden, New Jersey, has twice had successful experience in floating tanks up to 120 ft in diameter for distances of 400 ft or more. In neither case have we found it necessary to use internal bracing. The need for internal bracing is also discounted by leading tank fabricators. This applies both to cone and floating roof tanks. We have heard of some instances in moving floating roof tanks where braces were placed around the roof leg supports and knee braces installed between the tank shell and bottom. Our experience dictates that this is not required, however.

If these 80 ft diameter tanks are of riveted construction, in all probability the shell and bottom seams may require recaulking.

Procedure used at Bayway in floating tanks is outlined below:

1. Tank is first taken out of service; thoroughly cleaned and inspected. Based upon the remaining service life of the tank we determine whether justification exists to repair and float the tank or to dismantle it. Assuming justification does exist we make bottom repairs before the tank is floated.

2. Area is carefully surveyed — dikes built and area graded so that no high spots exist to hang up the tank.

3. New foundation is then prepared. All sewers in the area are sealed off. Sealing is usually accomplished by laying a flat plate, with cable attached, and cement grout placed over the plate to seal off the sewer.

4. If, from our metal inspection data, it is found that the second shell course is of sufficient thickness, a pad eye is welded to the middle of that course. It is good practice to weld the pad eye either to the first or second shell course. This allows as straight a pull as possible. The pull point on the tank and the anchor set on the shore side — if lined up on the new centerline of the tank greatly facilitate its final setting.

5. At least five 4 by 4-in. wooden markers are driven into the ground adjacent to the tank foundation periphery spaced at 45 deg intervals. These act as guides to center the tank as it is floated over its new foundation.

6. Pull cable is attached to pad eye and winch of a bulldozer that is located outside the area to be flooded.

7. Rope or cable guide lines are also attached to both sides and the rear of the tank. These may be handled by two or three men each or by a small bulldozer. Rear cable acts as a hold back while two side cables control side movement of the tank.

8. Area is gradually flooded — the quantity of water required having previously been calculated. We have heard of people em-

---

Your Operators' Forum editors went to two sources for the answer to this question. Shell Oil Company recently moved 10 tanks by this method, (see "Sea-Going Storage Tanks to New Berth," THE REFINING ENGINEER, December 1956, p C-44), and have advised us that no internal bracing was required. We received the same answer from the mechanical engineering department at Esso's Bayway refinery, whose reply is given here.

KEY® RETURN BENDS– KEY-KAST FITTINGS in service at new Tidewater refinery

In Tidewater Oil Company's giant new Delaware Refinery, where "firsts" are commonplace, and "world's largest" describes many of the units, KEY products were chosen for their efficient, economical, long-lasting service.

The furnaces are equipped with KEY 5000 Type Return Bends. Their simple design, rugged construction mean dependable service. Only 26 parts for 18 different size fittings in two series mean substantial savings in inventory. In addition KEY 180° type "W" welding fittings were extensively used.

KEY-KAST alloy steel welding fittings in ells, tees and caps were furnished in schedules 40 and 80, sizes from 16" to 24", in low chrome moly steel.

KEY Return Bends and KEY-KAST fittings are bringing dependability and economy to refineries throughout the world. Specify KEY and KEY-KAST products for your next job.

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KEY 5000 Type Return Bend
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ONE CONTROL DOES 2 JOBS

MERCOID DA-400 SERIES

Pressure Controls are dual purpose controls, incorporating a single pressure element operating two separate, independently adjustable Mercoid magnetic switches. The switches may be used for multiple circuit control for various operations as the control responds to pressure changes.

For example:

- Close one alarm circuit at high pressure and another at low pressure with both circuits open over operating range.
- As an electrical interlock to open one circuit as pressure rises above and the second circuit as the pressure drops below operating range.
- To provide two-stage control by opening or closing one circuit on a rise in pressure and the second circuit on a further rise in pressure.

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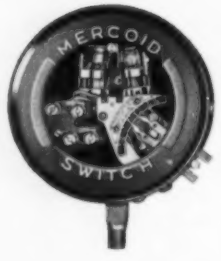

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Our engineers are at your service—send in your control problem or WRITE FOR BULLETIN NO. 92.

THE MERCOID CORPORATION—4211 Belmont Ave., Chicago 41, Ill.

FIG. 1. While bottom repairs are being made, the area must be surveyed carefully—dikes built and area graded so that the tank won't get caught on high spots.

FIG. 2. S. S. 255 underway. Note the stakes that are used to guide placement of the tank.

FIG. 3. Secured in a new berth. Don't pick a windy day to float a tank . . . even gusts of wind during the operation make control of tank movement very difficult.

ploying jacks to break the suction between tank and foundation and consequently use less water. We feel that this practice will cause stress reversals that could prove costly. On occasion jolting the guide lines will break the suction.

9. When tank is bouyant, little effort is required to float it into its new position.

10. If it is required that the tank be rotated to face in a different direction a cable is looped twice around the tank—cables clamped at the tank and the end hooked to bulldozers. Depending upon desired rotation one clamp is removed — pull exerted by bulldozer — and tank rotates slowly into desired position.

11. When tank has been positioned, weighted steel and cement sewer covers are pulled off by means of attached cables and water drains out through the sewers. Floating of tanks is a relatively easy, safe, and economical operation. Try to pick a day when there is very little wind velocity. Gusts of wind during floating operations make control of tank movement extremely difficult.

Photographs depict the various phases of a tank floating operation. The particular tank involved was a 93-ft diameter by 35 ft high cone roof tank that had a 6-in. reinforced concrete bottom. Tank was moved approximately 300 ft in a matter of 15 to 20 min and required approximately 14½ in. of water to become bouyant. Preparation of site and filling of dikes with required amount of water are the time consuming factors in floating tanks.

F. S.

DU PONT *Petroleum Chemicals* NEWS

One of a Series of Bulletins for the Petroleum Industry

JUNE 1957

World's first TEL tank-ship commissioned

NEW ASSISTANT REGIONAL MANAGER

WILLIAM W. WINGATE was recently appointed assistant regional manager in the Petroleum Chemicals Division's Mid-Continent Region, with headquarters in Tulsa, Oklahoma. He replaces Barrett B. Russell, III, who has been transferred to the Gulf Coast Region in a similar capacity.

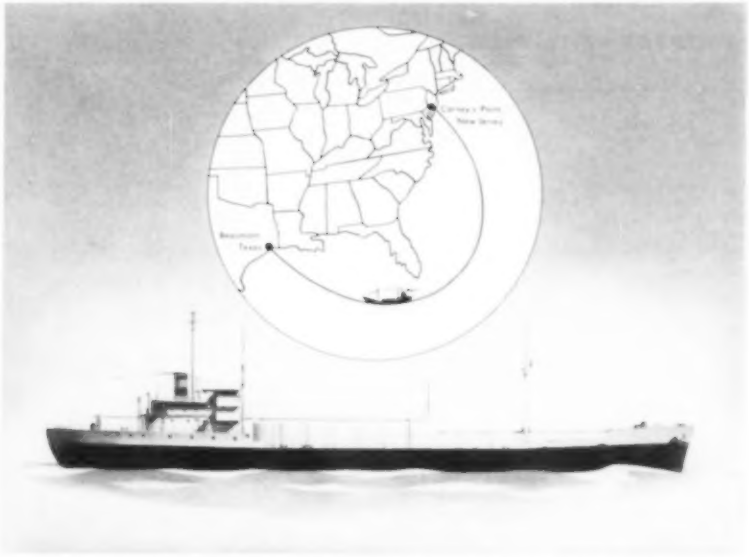
Previously Bill was active in regional sales and technical service work on all DuPont additives other than tetraethyl lead. This includes DuPont Estersil GT grease thickener, metal deactivators, lube and fuel oil additives, antioxidants, dyes and grease stabilizers.

Bill Wingate had an early introduction to the oil industry doing gasoline and lube oil testing for Socony-Mobil Oil Company, Inc. while earning his B.S. degree in chemical engineering at the University of Pennsylvania.

During World War II, Wingate was a lieutenant in the Navy and spent three years on submarine duty with the Pacific Fleet.

He is a member of Sigma Xi and Tau Beta Pi.

Rebuilt ship brings convenient Du Pont TEL supply to Gulf Coast refining area



MV PETROCHEM – the first chemical carrier for overwater transport of bulk shipments of TEL antiknock compounds. Rebuilt for the exclusive use of DuPont, the 6,000-ton tank-ship was recently put into service to meet the expanding needs of Gulf Coast refiners.

SHIP-SUPPLIED STORAGE AND DELIVERY TERMINAL AT BEAUMONT COMPLETED

Another important TEL delivery convenience for Gulf Coast refiners became a reality with the recent rechristening of the MV PETROCHEM – the first TEL tank-ship. This unique ship makes possible a major source of DuPont TEL supply right in the Gulf Coast area.

Also, TEL handling facilities have been constructed at Beaumont, Texas. These will provide dock accommodations for the new ship, and storage and distribution facilities for its cargo. Thus, the Beaumont terminal is equipped to provide the same TEL-availability and delivery service as DuPont's manufacturing plants at Carney's Point, New Jersey and Antioch, California.

Bulk shipments

MV PETROCHEM'S maiden voyage marked the first time tetraethyl lead compounds have been transported over water in bulk. To accomplish this safely, the tanker was redesigned and rebuilt, from the hull up, to rigid DuPont specifica-

OVER

DU PONT *Petroleum Chemicals* NEWS

Diesel locomotive fuel problem solved with Du Pont additive

R. R. SHOP SUPERINTENDENT:
Incompatible economy diesel fuels are causing injector-sticking and filter-plugging that cost us plenty in time and money.

OIL SALESMAN:
We've been hearing that lately. Incompatibility *is* the problem — but there's a way to solve it. I'll tell the refinery about it.

REFINERY EXECUTIVE:
Yes, I've been reading your ads telling how Du Pont's FOA-2 helps eliminate most diesel fuel incompatibility troubles. What about it?

DU PONT REPRESENTATIVE:
That's right, it does! Here, let me show you our data. I'll show your customer, too.

R. R. SHOP SUPERINTENDENT:
This injector's clean as a whistle—and it's been in operation 35 days.

DU PONT REPRESENTATIVE:
In most cases Du Pont FOA-2 keeps fuel oils gum-free. And while it helps prevent injector-sticking, filter-plugging it does not contribute to sparking tendency, because it burns without ash.

CONTINUED

Tanker shipments

tions—so rigid, in fact, that the PETROCHEM meets or exceeds the requirements of any port authority in the world!

TEL to Texas — raw materials back

The converted ship is in reality a two-cargo vessel. Designed primarily to move bulk shipments of TEL south from Carney's Point, it is also equipped with separate tanks for transporting ethyl chloride and ethylene dichloride back to Carney's Point.

Safety for crew and cargo

The PETROCHEM is permanently compartmented, with solid bulkheads dividing the operational and cargo sections. Still other solid bulkheads — welded to the hull itself—separate each of three cargo spaces. Safety and product cleanliness were the primary design considerations.

Unique features

Many new safety features were specially designed for this 6,000-ton tankship. Each compartment is ventilated separately by a system which effects a complete change of air throughout the entire ship every three minutes. A vacuum system is another of the many special facilities for safe maintenance, repair, and product handling.

If you operate a refinery in the Gulf Coast area, the new ship and terminal are your assurance of a nearby ample supply of Du Pont TEL.

Voice of America to broadcast Magic Barrel excerpts

Parts of the oil industry's "Magic Barrel" presentation have been recorded for broadcasting to people behind the iron and bamboo curtains as well as in free countries of the world.

Members of the Voice of America staff first became acquainted with the Du Pont-designed Magic Barrel when visiting the company to develop a special program using the voices of approximately 100 foreign-born and native American Du Pont employees. At this time, the Magic Barrel was shown to the Voice staff to acquaint them with the group of Du Pont products made from oil. They saw in this presentation some of the fruits of American enterprise — presented in a dramatic and convincing fashion. So they asked to have parts of it taped for broadcasting to their listeners.

The Magic Barrel broadcast has been included in a more comprehensive program in 32 languages under the title, "The People's Capitalism."

This program will also explain the widespread sharing of benefits under the American economic system and tell some of the history of the Du Pont Company. Recorded interviews with employees who emigrated from 44 foreign countries will appear on the program, along with company executives, scientists and union representatives. The interviews were all spontaneous . . . no prepared scripts.

The Voice of America program is the first concerted effort to tell the story of an American company in many languages.

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OVER

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A-4635

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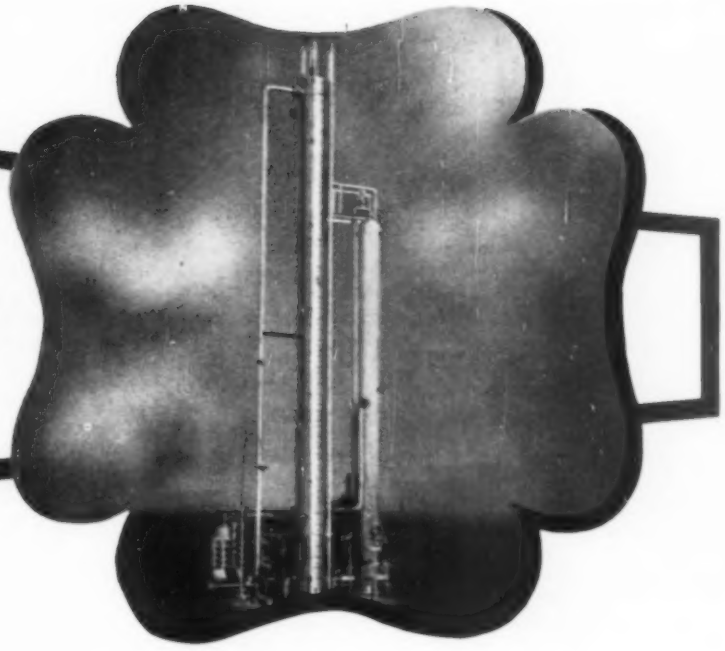
McNAMAR



portable gasoline plant

The McNamar portable gasoline plant is designed to control the hydrocarbon content of sales gas and to economically recover natural gasoline and LPG.

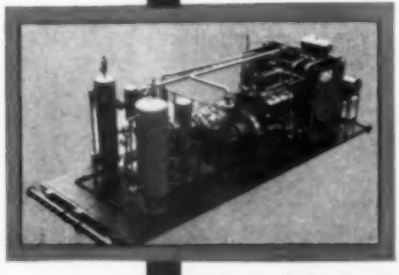
The plants are also designed to fractionate the distillate, if desired. The ease of moving from one location to another, the simplicity in design, and the dependable operation of this unit are factors that greatly reduce operating and maintenance costs.

The usage of the McNamar portable gasoline plant is extremely flexible. The unit can be completely operated automatically, saving time and costs.

For dependable, economical gas plant operation, you can be assured of complete satisfaction when you purchase McNamar quality equipment.

Call, write or wire McNamar for further information.

De-Sulphurization Plants • Glycol and Solid Dessicant Units



The McNamar Joy WNB 112, 200 horsepower, twin cylinder Gas Compressor features compactness, portability and versatility. The units are completely packaged, easily installed and economical to operate.

The McNamar Joy-Gas Compressor units may be engineered to your application and are available on purchase, rental and rental-purchase option basis. 50, 100, 300 and 400 horsepower sizes also available.

McNAMAR BOILER & TANK CO.

BOX 868 — TULSA, OKLAHOMA CHerry 2-6291

Progress in Natural Gasoline Plant Instrumentation

AUTOMATION of compressors and auxiliary rooms in natural gasoline plants is possible, but little has been done about it in recent years, according to Tulsa consultant A. Ray Wagner. Wagner told the national meeting of the Natural Gasoline Association of America (Houston, April 24-26) that the same principles used for automatic pipeline stations can be applied in natural gasoline plants to obtain safer, smoother, and more efficient compressor operation.

For example, oil level regulators have been developed that will enable complete automatic lubrication of each engine. And, some plants are now being equipped with instruments that will regulate the speed of compressors according to the gas volume available.

Decreased maintenance is just one of the benefits of controlling compressor rpm, according to Wagner. Operation at constant compression ratio is provided by governors operating from a standard 3-15 psi air signal or electronic signal.

Wagner said that there are engine control units now being designed specifically for gasoline plants. These units will shut down engines due to overspeed, high jacket water temperature, low oil pressure, knock, or high scrubber level. The units pinpoint the trouble by a pilot light, close the main fuel valve, and sequentially unload the compressor. Sequential start up is accomplished by the same units, too, an operation which usually requires two men and perhaps a half hour's time.

Process Control Systems

There have been five significant developments in continuous production process instrumentation within the past 10 years, according to Magnolia Petroleum's Robert R. Click. Click told the NGAA that these were:

1. Pneumatic or electrical transmission between the measuring element and the recorder or controller.
2. Miniature recorder-controllers.
3. Greater use of electronic control.
4. Continuous stream analyzers.
5. Automatic data loggers.

Click did not dwell on the last item very long, pointing out that there is little or no incentive for data loggers in gasoline plants because of high cost and the limited volume of data usually handled in a gasoline plant. And, F. W. Karasek of Phillips Petroleum Company had covered the subject of continuous analyzers during the meeting.

Transmission systems in gasoline plants are worthwhile, according to Click's experience. He said that they are superior to directly connected measuring element control element systems because of faster measurement response, standard narrow range bands, flexibility in range adjustment, better reliability, and lower maintenance. Maintenance reduction is a very significant point in favor of transmission for flow applications, particularly where seals would be required. And, he pointed out, even though pressure and temperature applications require an extra instrument when using transmission, maintenance considerations are not a big deterrent.

Miniature instruments have a lot of advantages over rectangular cased instruments. Click said that the "plug-in" feature of the miniature units eases maintenance problems, reduces control room space requirements, and has features not included in retangular case instruments. And, while cost of the miniatures is somewhat higher, it is not too significant when considering the advantages, Click claimed. He tabulated costs of various types of pneumatic instruments as follows:

	— Rectangular Case* — Direct Connected	With Transmitter	— Miniature With Transmitter
Temperature	$675	$750	$770
Pressure	480	700	720
Flow	620	730	750

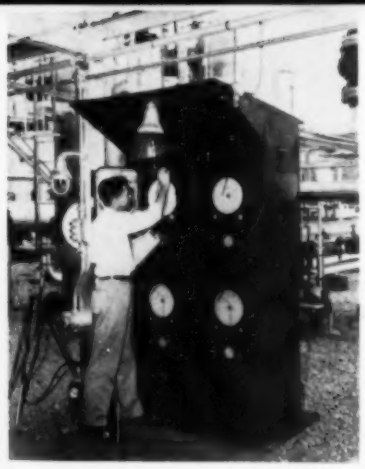
*Price includes $50 for optional four position automatic manual switching unit.

Click said that two quotations on panel boards with 20 single-pen mounted reflected a $1000 savings for the miniature units.

Electronic control systems can compete in cost with comparable pneumatic systems. Click believes would probably be cheaper to maintain — if a repairman with both electronic and pneumatic operations were available. He did not attempt to settle the pneumatic electronic controversy, but did point out these advantages and disadvantages for electronic systems:

1. Better adaptability to process monitoring and analysis systems.
2. Adaptability to a greater number of applications.
3. Lack of standardization in electronic signal ranges, making interchange of one manufacturer's system with another difficult.
4. Power failure means instant loss or control action without standby power generating units.

Summing up, Click said that only experience will settle the pneumatic-electronic argument, and that a purely electronic control system is still in the future as far as gasoline plants are concerned with lower-cost electro-hydraulic or electric valve operators being one of the biggest hurdles to cross.



The trend is to move outside sheltered instrument panels (above) like this unit . . . into central control rooms, (below) replacing the conventional rectangular-cased units with miniature recorder-controller units mounted in a compact console designed for gasoline plant service.

Use of miniature recorder-controllers can save as much as $1000, piped and mounted, over rectangular-cased units in a plant using 20 single-pen units.

— Photos Courtesy Magnolia Petroleum Company

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to build a better plant
Building is a business of men. Men with vision, with knowledge, with broad experience. Here at Procon we've concentrated on getting and keeping the best of them.
For years, the world over, Procon men have been planning and building refineries, petrochemical and chemical plants . . . to specifications and on schedule, time and again surpassing any reasonable goal.
We're proud of our men at Procon. To us they are truly those men of vision who do build better plants. Together they provide a complete design, engineering and construction service.
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CONSOTROL* RECORDING

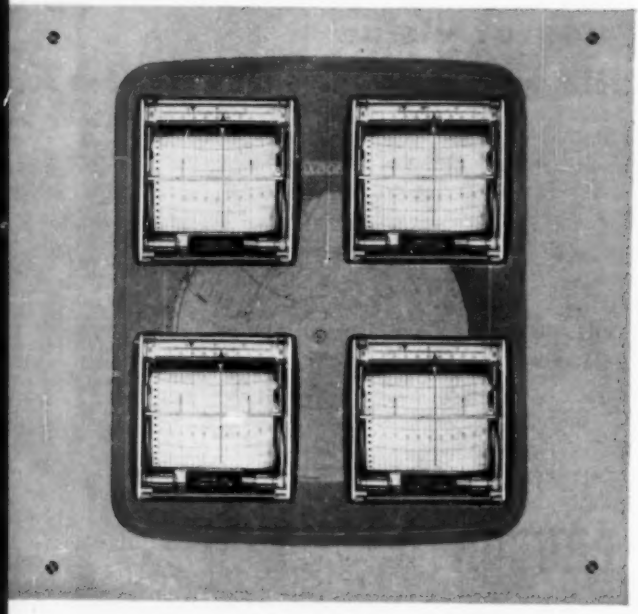
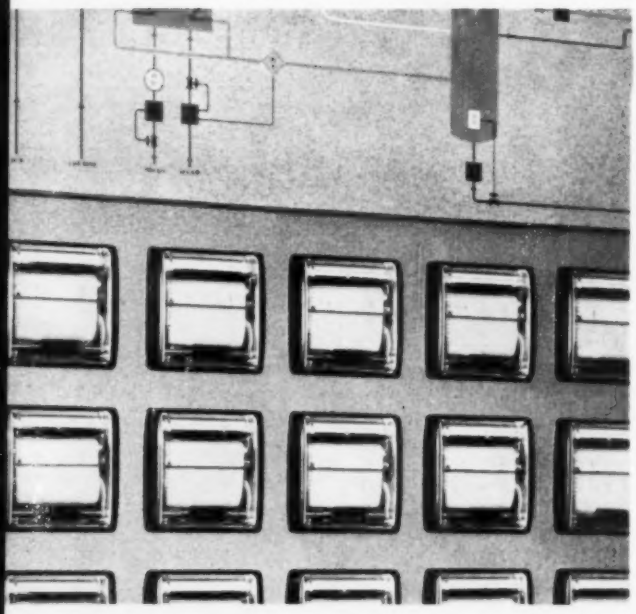


Illustration shows how 4 Consotrol Instruments require less panel space than does a single, conventional 12" recorder.



Typical control panel showing Consotrol Recording Control Stations. Associated M/58 Controllers, integrally mounted, pull out with the recorders.

The ORIGINAL small-case control panel instrument with a

FULL SCALE 4 INCH CHART...

Full-scale *readability!* Here is the industry standard set by Consotrol Instruments, with no compromise in compactness, convenience, or performance.

These Recorders and Recording Control Stations are so compact you can actually mount 4 in the space required by 1 standard 12-inch recorder. And yet, inside the case, all components are full size — nothing is "miniature."

With the integrally mounted Model 58 Controller, the Foxboro Consotrol Recording Control Station provides precise, dependable control and full-scale chart records in one-quarter the panel space. Maintenance is easier too, with all calibration adjustments made from the front . . . re-inking needed only twice a year . . . chart changes as seldom as once a month.

For the complete story, write for Bulletin 13-18. **The Foxboro Company, 646 Neponset Avenue, Foxboro, Massachusetts, U.S.A.**

INTRODUCED IN 1952 — OVER 25,000 NOW IN USE

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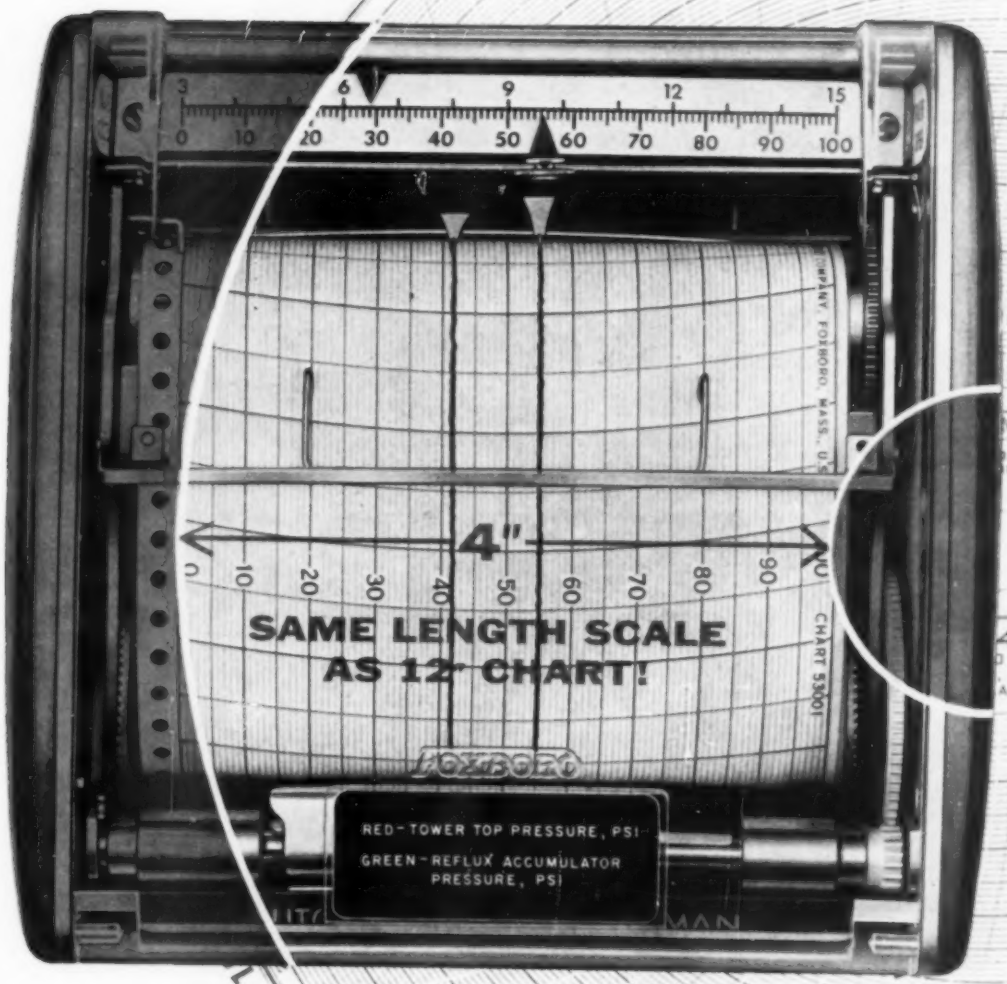
CONTROL STATION



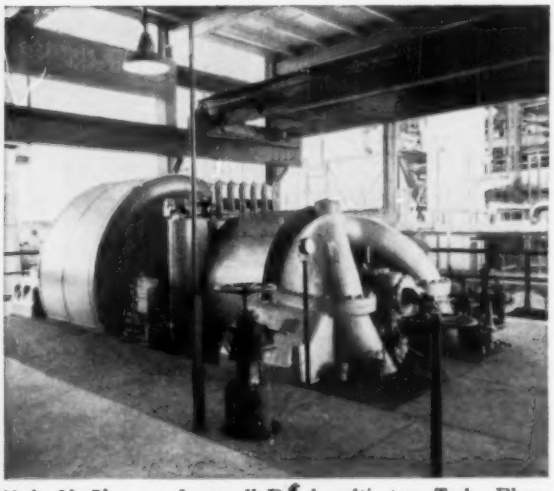
ACTUAL SIZE illustration of Consotrol Instrument super-imposed on standard 12-inch chart. Note full 4" wide chart same scale as 12" circular chart.

CONSOTROL INSTRUMENTS

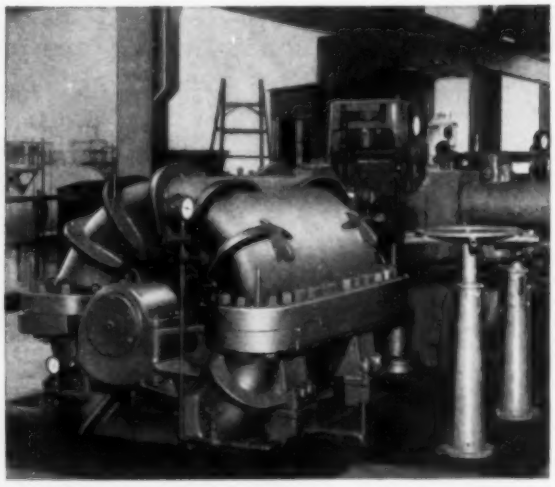
RECORDING · CONTROLLING · INDICATING

Turbo-Blowers and Compressors meet *all* the air and gas handling requirements of

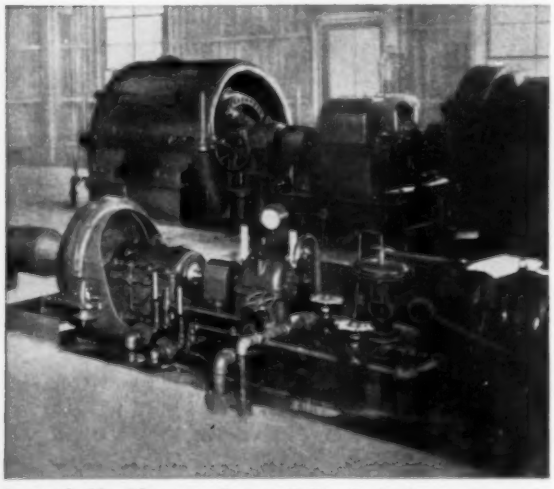
MODERN CATALYTIC CRACKING SERVICE



Main Air Blowers. Ingersoll-Rand multi-stage Turbo-Blowers meet all requirements for main air blower service in catalytic cracking plants. They have been built for capacities up to approximately 160,000 cfm. Although usually driven by I-R steam turbines, they also can be driven by combustion gas turbines or electric motors.



Gas Compressors. Ingersoll-Rand centrifugal compressors can be supplied for all gas discharge pressures and capacities encountered in catalytic cracking service. A variety of sealing arrangements is available and two or more units can be operated in series and tandem, providing virtually unlimited range and flexibility of ratings. They can be powered by I-R steam turbines or any other type of drive.



Control Air Blowers. Ingersoll-Rand single- and multi-stage blowers are ideally suited to the exacting requirements for dependable control air service. The single-stage units have center intake and the discharge nozzle can be positioned as desired, for horizontal, vertical or underfloor piping. I-R Control Air Blowers are ideally suited for all types of drivers.

IN CATALYTIC cracking service, where unscheduled shut-downs are extremely costly, there is simply no substitute for the dependability that is built into every Ingersoll-Rand unit. The proved performance of these I-R units in continuous heavy-duty service reflects the care and precision that goes into every construction detail.

For experienced, dependable counsel on the application of air and gas handling equipment, consult your I-R representative. Also, ask him for your copy of Form 8276.

12-574

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TURBO BLOWERS • AIR & ELECTIC TOOLS

Any Size...Any Design

Size or complexity makes no difference to the prompt and efficient service that The M. W. Kellogg Company offers to the process industries on heat exchangers. Whether it's an order for a single 14-ft. diameter giant, like the one above, or a group of normal size units, Kellogg's recently expanded facilities are geared to produce to the strictest design standards and delivery schedules. With these facilities, Kellogg can handle the complete job of designing, engineering, and fabricating heat exchangers, or make exchangers to customers' own designs.

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REFINING AND PETROCHEMICAL

PERSONALS

▸ Three well-known oil men were given special honors at the 22nd mid-year meeting of the Division of Refining of the American Petroleum Institute in Philadelphia, Pennsylvania.

Recipients of Certificates of Appreciation were **D. P. Barnard,** research coordinator for Standard Oil Company (Indiana), Chicago; **Hugh W. Field,** vice president and general manager of research and development, Atlantic Refining Company, Philadelphia, Pennsylvania; and **Dr. J. Bennett Hill,** pioneer oil chemist and recently retired director of research and development, Sun Oil Company, Marcus Hook, Pennsylvania.

They were given certificates in recognition of long and meritorious service with the Institute and its committees, and of their contributions to petroleum technology.

▸ **W. R. Smith** has been named technical assistant for the Texaco Development Corporation, the licensing and patent subsidiary of The Texas Company, at the company's Port Arthur, Texas, research laboratories. Dr. Smith has been assistant supervisor of chemicals research at Texaco's Port Arthur-Port Neches laboratories.

A. D. Togna has been named supervisor of the recently-established products testing department of the Texaco Research Center at Beacon, New York. Togna was formerly assistant supervisor of the center's analytical and testing department. **Samuel P. Dickens** has been named supervisor, project evaluation research, at Texaco Research. He was formerly assistant supervisor, fuels research, at the company's Port Arthur-Port Neches, Texas, laboratories.

▸ The Atlantic Refining Company, at its Philadelphia refinery, is reorganizing the operating departments into one division and combining certain service divisions. **C. W. Stose,** formerly general manager of the company's crude oil purchases and sales activities, has been named general superintendent of the process division. **W. O. Hoffman,** formerly superintendent of the refinery's mechanical department, was named general superintendent of the services division. **J. K. Deichler** and **T. J. Lavin** will continue as superintendents of the mechanical inspection and plant protection divisions, respectively.

▸ **Walter F. Rogers,** chief chemist, Houston (Texas) production division chemical laboratory, Gulf Oil Corporation, and **Carl Wagner,** professor of metallurgy at Massachusetts Institute of Technology received the 1957 awards of the National Association of Corrosion Engineers. Rogers received the Frank Newman Speller Award for achievements in corrosion and Dr. Wagner the Willis Rodney Whitney Award for achievements in corrosion science.

▸ **Dr. Donald E. Burney** and **G. Hans Weisemann** have been advanced to section leaders in the chemical products division, and **Dr. Philip H. Towle** is named group leader, research and development departments, Standard Oil Company (Indiana). In the development and patent department, **Dr. Philip Hill** is advanced to senior patent advisor in the information development division, and **Thomas E. Earle** to patent advisor. **J. Robert Stapleton** is appointed patent searcher; **Douglas G. Brace,** patent licensing coordinator, and **Raymond F. Maldoon,** technologist. In the administrative division, **Robert E. Pritz** is appointed records control supervisor.

▸ **Dr. Alfred G. Rossow** and **Fred A. Escherich** have joined the market research and analysis department of Socony Mobil Oil Company, Inc., to do research for the company's new petroleum chemicals department. Rossow was formerly with Monsanto Chemical Company and General Foods, doing research and development work for both companies. Escherich was with American Cyanamid Company (at its Stamford research laboratories and market research department) and with Pan American Chemicals, Inc.

▸ **Ralph L. Ericsson** has been appointed general sales manager of Texas Butadiene & Chemical Corporation with headquarters at the company's office in Houston, Texas. He was formerly vice president in charge of sales and executive vice president of Sumner Chemical Company of New York and Zeeland, Michigan.

R. L. Ericsson

J. L. Walker

▸ **James L. Walker** has joined Purvin & Gertz, Inc. consulting engineers, Dallas, Texas. He was formerly associated with Humble Oil and Refining Company in the technical service division at the Baytown, Texas, refinery. He will serve as a staff consultant for the petroleum refining and petrochemical industries.

▸ **Royes Salmon** has joined the engineering department of Houdry Process Corporation as a senior process engineer. He previously was with Union Oil Company's research center in Brea, California, as a senior process engineer. Prior to this, he was associated with Foster Wheeler Corporation in New York.

▸ **James F. Grutsch** has been named group leader in the heavy oils, asphalt and ammonia technical service division of the research department of Standard Oil Company (Indiana) at Whiting, Indiana.

▸ **John B. O'Brian** has joined Leonard Refineries, Inc., as director of personnel. He came to Leonard from The Lumbermens Mutual Insurance Company of Mansfield, Ohio, where he served as personnel manager since 1954. He previously was with Michigan Bell Telephone Company.

▸ **Franklyn M. Moffitt** was elected a vice president of the Ashland Oil & Refining Company, Ashland, Kentucky. He had been national account sales manager, and in his new capacity will have charge of sales of aviation fuels, railroad and industrial fuels and lubricants, petrochemicals and other petroleum specialties.

▸ **Dr. Carroll Karkalits** has been named supervisor of research for the Petro-Tex Chemical Corporation of Houston, Texas. Subsequently, for eight years he was group leader in the process development department of American Cyanamid Company at Bound Brook, New Jersey. Just prior to joining Petro-Tex, he was supervisor of economic and process appraisal in the central research laboratories of Food Machinery & Chemical Corporation at Princeton, New Jersey.

▸ **Kingsley V. Schroeder** was named Sun Oil Company's director of production. He fills the vacancy on the board created by the retirement in August 1956 of **R. W. Pack. Willard W. Wright** has been elected vice president in charge of marketing for Sun Oil, replacing **Frank R. Markley.** Markley, a director, will remain as a vice president on a new assignment to be announced later. Wright, also a member of the board, was formerly general sales manager of the company's marketing department.

▸ **H. F. Tomfohrde,** manager of Tidewater Oil Company's lubricants supply department, was selected by the company to attend the executive development program at the University of Pittsburgh from March 25 to May 17. The course is specially designed to provide executives chosen from companies throughout the country with an opportunity to broaden their knowledge of management techniques and gain insight into areas of business outside of their specialization.

▸ **Fred C. Boucke** has been appointed manager, Eastern Hemisphere staff, Standard Oil Company of California. Also announced was the appointment of **E. P. Fay Jr.,** as assistant manager. Boucke will manage staff services pertaining to the company's interests in the Eastern Hemisphere. He previously served as assistant to the vice president with responsibility for that area. Fay has been associated with the Eastern Hemisphere staff as a senior and supervising analyst.

▸ **Thomas L. Apjohn** of Melwood Lane, Westport, Connecticut, has been appointed manager of the newly created petroleum chemicals department of Mobil Overseas Oil Company, an affiliate of Socony Mobil Oil Company, Inc. Prior to his new assignment, Apjohn was manager of Mobil Overseas' lubricating department.

▸ **Jennings B. Hamblen** formerly assistant director of safety, has been named director of safety for American Oil Company. Hamblen succeeds **L. E. Mitchison** who retired recently.

NEW DEALER MEETING DEMONSTRATION—For a vivid demonstration of how carburetor icing causes stalling and how it can be prevented with DMF, ask our representative to show you the new single-cylinder engine assembly.

The new unit consists of a small ice tower and a 1.6-horsepower engine connected by a glass tube manifold. When ordinary gasolines are drawn through the tube, ice forms on a little metal valve and causes the engine to stall. But the addition of Du Pont DMF to the gasoline prevents any buildup of ice.

To convince your dealers and customers of the advantages of your new *no-stall* gasoline with DMF, we will be glad to help you build your own demonstration units.

Experiments reveal facts about carburetor icing

Recent experiments indicate that stalling due to carburetor icing occurs even in 55-degree weather. Moreover, they prove that Du Pont DMF (dimethyl formamide) provides the motorist with protection against this type of hazard and annoyance.

Stall-prevention is especially important in many cars having power brakes and power steering—both of which are less effective when the car-engine stops.

Dimethyl formamide proved effective in low concentrations

Its practical use concentration turned out to be under 0.10 volume per cent—in other words, less than three milliliters per gallon!

Long stalling season

Conditions under which your customers' cars can stall also became clearer. The "refrigerant" action of gasoline can lower the temperature of carburetor parts to freezing even on comparatively warm days. Generally speaking, temperatures from 22 to 55 degrees Fahrenheit can lead to carburetor icing when humidity is 65 per cent or higher.

Expanding de-icer market

Motorists are showing an ever-increasing interest in gasoline performance. By anticipating a greater demand next fall for gasolines which contain anti-stalling agents, you can increase the number of your cold-weather customers. Now is the time to plan for the day when temperatures begin dropping below 55 and carburetor icing begins.

Economy and reduced storage

DMF offers two important benefits—economy and minimum storage-space requirement. The low volume concentration that's needed represents a real saving in freight and blending costs. And, because of the high efficiency of Du Pont DMF, and the low concentration required, little storage space is necessary.

A Du Pont Petroleum Chemicals Division representative will be glad to give you more detailed information on DMF. You can contact him at any of our sales offices listed at right.

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705 Bank of Commerce Bldg. ..... CApitol 5-1151
Los Angeles 17—612 So. Flower St. . MAdison 5-1691
New York 20—
1270 Ave. of the Americas ..... COlumbus 5-2342
Philadelphia 2—3 Penn Center Plaza . LOcust 8-3531
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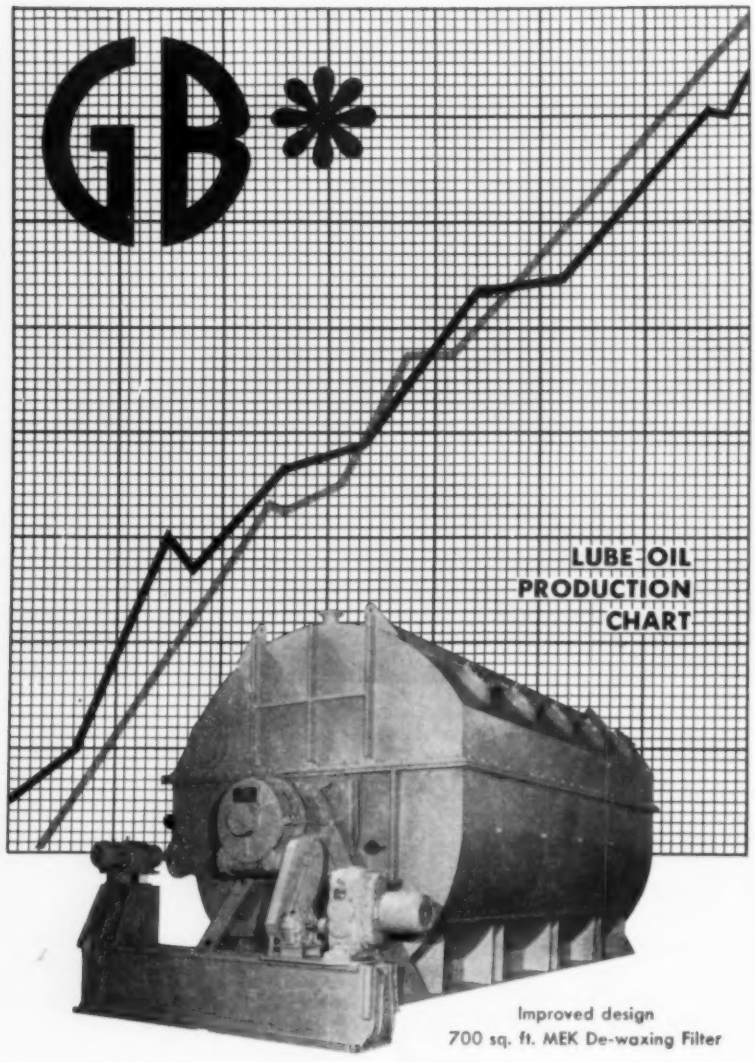

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700 sq. ft. MEK De-waxing Filter

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Over 25 years of experience assure you that Goslin-Birmingham can produce the best de-waxing filter to fit your requirements regardless of the process.

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Personals

▸ **Robert A. Byorum** has been named chief engineer and construction manager of Spencer Chemical Company. He was formerly chief engineer.

▸ **Charles E. Webber,** technical advisor to the vice president, Sun Oil Company, Philadelphia, Pennsylvania, has been given the highest honor in the natural gasoline industry and one of the ranking awards of the petroleum industry, the Hanlon Award given by the National Gasoline Association of America.

C. E. Webber

W. A. King

▸ **W. Adrian King** has been appointed general sales manager of the industrial chemicals division of Olin Mathieson Chemical Corporation. He has been manager of the division's automotive products department. He joined the former Mathieson Chemical Corporation in 1953 as manager of hydrocarbon chemical sales and before that was midwestern sales manager of the plastics division of the American Cyanamid Company.

The following appointments have also been announced: **James C. Laney,** formerly national accounts sales manager of the department, succeeds King. **James F. Newell** has been appointed assistant general manager of the industrial chemicals division. He was formerly manager of the products department. **Charles C. Hightower** succeeds Newell as production head, and was formerly manager of the Lake Charles, Louisiana, plant. **W. Carlton Moseley,** formerly assistant plant manager at Lake Charles, has been named plant manager. **Cecil L. Williamson,** who has been manager of the division's administrative services department in Baltimore, Maryland, has been appointed assistant to the division general manager.

▸ **John M. Olin** has been named chairman of the financial and operating policy committee and will also continue to serve as chairman of the executive committee, of Olin Mathieson Chemical Corporation. **Thomas S. Nichols** was named

T. S. Nichols

S. de J. Osborne

chairman of the board of directors. **Stanley de J. Osborne** was named president of the corporation. **John W. Hanes,** who reached retirement age in April, was appointed financial consultant to the corporation and a member of the financial and operating policy committee. He also continues as a director.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Personals

▸ The American Society of Lubrication Engineers has announced the election of **A. B. Two** of the Ford Motor Company and **B. T. Harding** of the Midwest Oil Company to the board of directors of the society. **L. O. Witzenburg** of the Farval Corporation and The Cleveland Worm & Gear Company, was elected industrial director. Directors elected replace retiring directors **A. E. Cichelli,** Bethlehem Steel Company, and **W. Lasky,** Gulf, Ohio & Mobile R.R. and **C. R. Schmitt,** of the E. F. Houghton Company, the latter having served as industrial director. The following officers of the society have been elected by the board of directors: **J. O. McLean,** president, Reynolds Metals Company; **J. D. Lykins,** vice president at large, Wheeling Steel Corporation, **J. L. Finkelmann,** secretary, Cycleweld Division, Chrysler Corporation; **J. W. Peterson,** treasurer, Standard Oil Company (Indiana); **T. A. Marshall,** Canadian regional vice president, Steel Company of Canada; **R. F. McKibben,** central regional vice president, National Cash Register; **M. E. Dougherty**, eastern regional vice president, Acheson Colloids Company; **A. B. Wilder,** mid-western regional vice president, E. I. duPont de Nemours & Company, and **R. C. Dishington,** western regional vice president, General Petroleum Corporation.

ASLE has bestowed awards on three outstanding engineers for their contributions to the science of lubrication during the past year. **Dudley D. Fuller,** professor of mechanical engineering at Columbia University and principle scientist at the Franklin Institute of the State of Pennsylvania, received the ASLE National Award, which constitutes life membership in the society for his "... conspicuous service to the science of lubrication . . . through research, educational leadership, and contributions to the literature." **Douglas Godfrey,** of the California Research Institute, was awarded the Capt. Alfred E. Hunt Memorial Medal for his paper, *A Study of Fretting Wear in Mineral Oil*, based on research undertaken while he was a staff member of the NACA. The award is presented for the best paper delivered before the society by a member or published in its journal *Lubrication Engineering* during the previous year. **Ernest Rabinowicz,** research engineer at the Massachusetts Institute of Technology, was presented the Walter D. Hodson certificate and cash award, given for the best paper presented by an ASLE member 30 years of age less during the previous year. Dr. Rabinowicz received the award for his paper *The Equilibrium Distribution of Transfer Fragments.*

▸ **Frank R. Markley,** vice president of Sun Oil Company, has assumed executive responsibility for the company's transportation functions. He formerly was in charge of marketing.

▸ **James M. Gill** has been appointed manager of the new Ethyl Corporation manufacturing plant under construction at Pittsburg, California. He served as acting general superintendent of maintenance and on-plant construction at the Baton Rouge, Louisiana, plant, and most recently has been on special assignment for the company.

▸ **Edgar B. Chiswell** has been appointed executive secretary of California Chemical Company, a newly created chemical subsidiary of Standard Oil Company of California. He was formerly manager of process research and development for California Research Corporation.

Now . . . handle bigger lifts with a **BANTAM!**

. . . greater stability at any working range!

Here is the new 8-ton BANTAM with its specially engineered Model 300 crane carrier mounting—offering you increased crane capacity, *with or without* outriggers, at normal working radii (15' . . . 20' . . . 25') to handle your crane jobs faster, at lower costs.

BANTAM's job-matched performance between carrier and basic machine gives you more lifting capacity per pound of weight than any other rig in its size class! BANTAM engineering know-how, based on more than 8000 machines in the field, is your assurance of a rig to handle your heaviest work without sacrificing mobility and maneuverability because of excessive "dead" weight.

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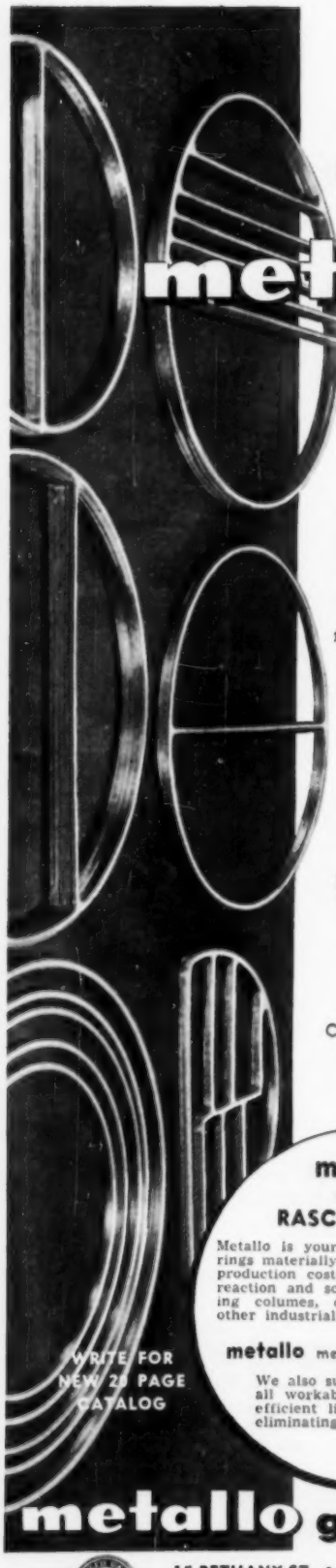

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Fabricated in special shapes to exact specifications. Under fatigue of severe operating conditions, they are superior in sealing efficiency, longevity and ability to retain physical and chemical properties. These gaskets are built for specific purposes in strict accordance with customers' requirements or templates. When used for recommended services, they completely satisfy and give extra long life. A group of specially constructed Metallo Gaskets are made for heat exchangers with metal jackets and asbestos filler. These gaskets, including irregular shaped gaskets for any process equipment, are readily made in several different styles and shapes, in any metal and in sizes limited only by transportation facilities. These gaskets are also cut from solid sheet metal.

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Metallo is your primary source. These rings materially decrease operating and production costs on a wide variety of reaction and scrubbing towers, rectifying columes, extraction systems and other industrial processes.

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We also supply Lessig rings in all workable metals to act as efficient liquid distributors by eliminating cross flows.

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Heat Exchangers, Raschig Rings, Lessig Rings, Gaskets, Valve Discs and Metal Stampings

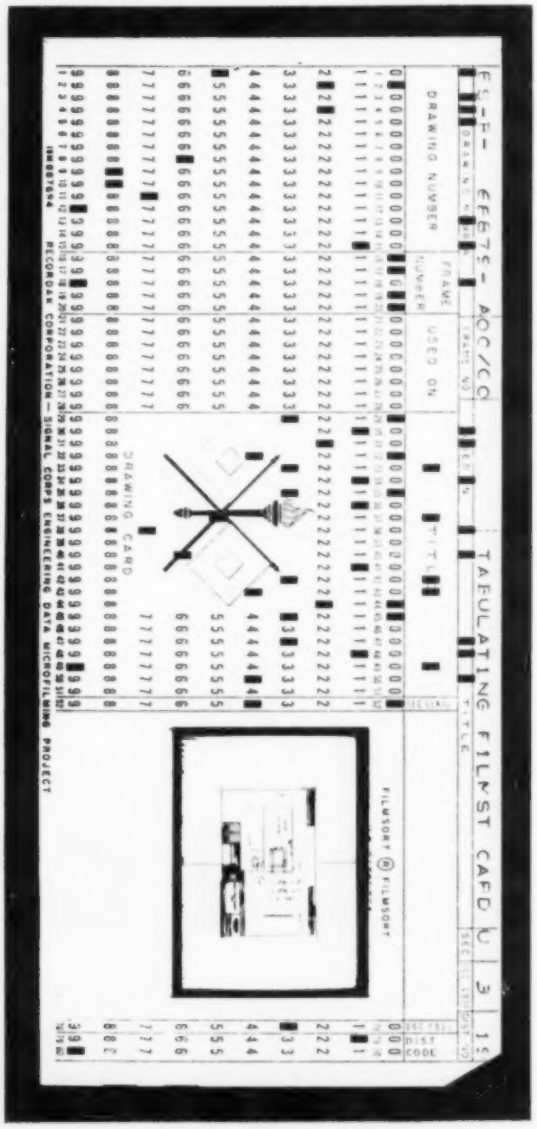
Microfilm "Windows" Streamline Procurement, Cut Filing Costs

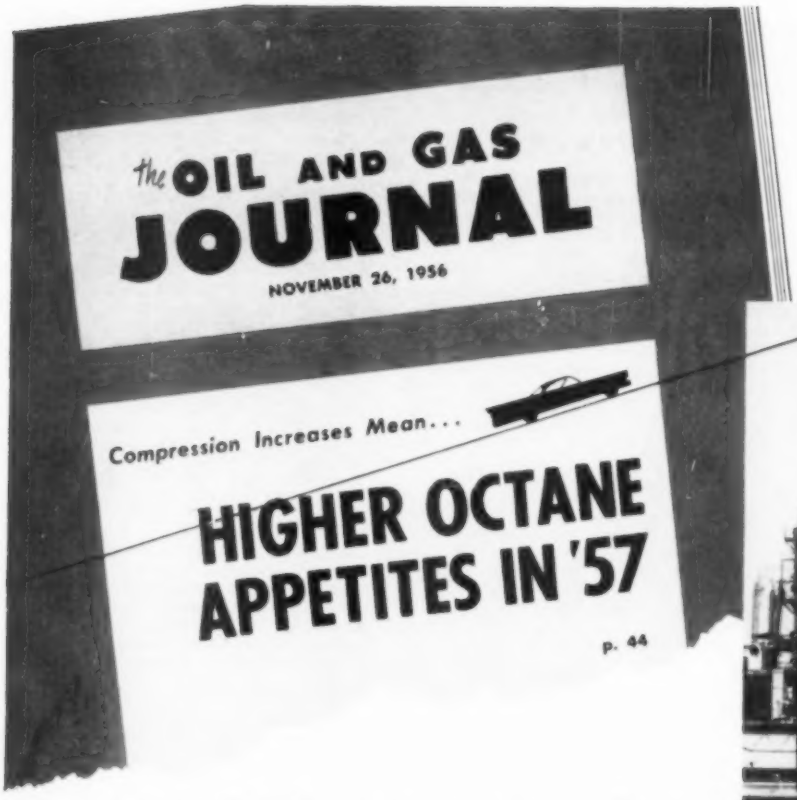
Plant engineering offices could easily take a tip from the Army's Signal Corps in reducing costs and increasing efficiency for transmitting engineering drawings. Microfilm "windows" in tabulating cards are made from the original microfilm negatives. The cards are being distributed to various Signal Corps installations for reference in the repair and overhaul of equipment and for procurement purposes.

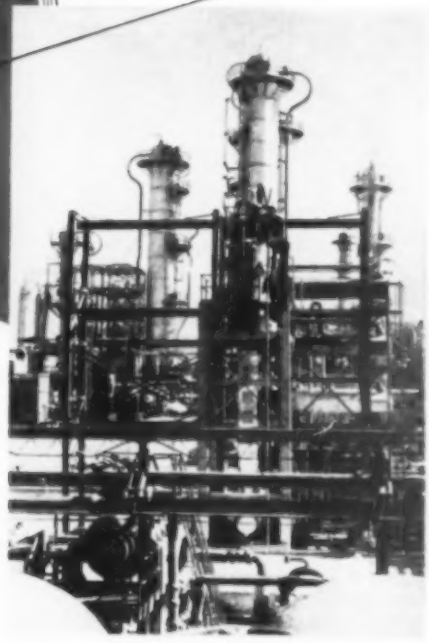
They will also be used to make reduced-size paper prints to use for issuing bids. This new system replaces the old, costly method of making full-size paper reproductions of drawings. Result reduced filing space and cost and easy access to desired drawings when used in conjunction with punched card sorting machines.

Many industrial concerns have microfilmed engineering drawings and records in order to safeguard this valuable material in the event of emergency.

Punched cards aid in classification, storage, and location of microfilms for engineering drawings and records. Corner notches and colored stripes differentiate cards when filed manually.







Booming high octane market spurs alkylation...

Monel resists HF corrosion... permits safe, non-stop operation for a year or more

Boosting pool octane values calls for quantity as well as quality in the premium fraction.

So, in HF alkylation, the heat's on for (1) high-stream velocity and (2) non-stop operations.

But with increases in stream velocity, the HF corrosion rate may go up. Without special protection, more inspection shutdowns are called for.

To get around the impasse producers rely on Monel

Major operators have increased their onstream time to a year or better by using Monel* nickel-copper alloy freely in critical equipment. One company reports a two-year inspection schedule.

These companies depend on Monel alloy to resist both aqueous and anhydrous HF attack at elevated temperatures and pressures.

In acid regenerators, steam reboilers, feed pre-heaters, condensers, fractionating towers... Monel alloy or Monel-clad construction provides years of trouble-free life.

In valve, pump, and instrument parts with close tolerances, it eliminates undesirable build-up of corrosion products. As relief valve rupture discs and gaskets, it helps assure safe operation.

Chances are, Monel alloy could help you increase throughput and operate safely over longer periods.

Look into the matter today. Write Inco's Corrosion Engineering Section.

*Registered trademark

When to consider Monel for HF alkylation equipment. Monel nickel-copper alloy provides useful resistance to HF in all concentrations and (in unaerated solutions) up to 250°F. It is used with the anhydrous acid at temperatures up to 1100°F. Monel is comparatively unaffected by high stream velocities. Its strength and wear resistance are high.

INCO TRADE MARK Nickel Alloys

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Monel ... for minimum maintenance

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

NEW Refining Equipment

• machinery • supplies • services

For more information on items described here in brief, use the handy reply card and circle the corresponding numbers

Danger Signals. A new product called the Danger Signal Bull Plug has been added to Crawford Fitting's Swagelok line. Free hanging, Danger Signal Bull Plugs with their brilliant red bands quickly pin point the locations of dangerous openings in piping lines. They cannot get lost, misplaced or carried away from the job since each plug incorporates a permanently attached chain and ring at the unthreaded end. Ring may be used to circle the valve or piping, or the chain may be spot welded to the line. Plug is easy to remove and replace because its long shank provides a good grip. A long thread is provided to meet installation conditions normally encountered. *Crawford Fitting Company.*

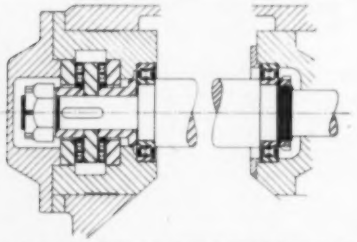
Circle number (41) on reply card.

Dry Acid Compound. Oakite-Drycid, a new powdered acid material which removes rust, scale and corrosion with greater safety to metal surfaces as well as personnel, has been introduced. Added to water in concentrations upwards of 8 ounces to the gallon, Oakite Drycid goes into solution fast and is useful in applications by circulation or immersion. Solutions of the compound may be used cold or for faster action, heated to 165 F. It is effective in the removal of scale, scale-like deposits, rust, iron sulfides and other oxides. Advantages of this new material include its ease in shipment and in storage; its mild, aromatic odor and non-fuming characteristic; its greater safety on aluminum, brass and galvanized surfaces. *Oakite Products, Inc.*

Circle number (42) on reply card.

Special Double-Acting Thrust Bearing. This bearing has been designed to withstand extremely heavy gear reduction unit thrust loads from either direction. Flat-seat type bearing, with 2-in. bore and 6 3/16 in. OD, consists of center plate, 2 roller assemblies, 2 stationary plates, and 2 rotating inner sleeves.

Plates, ⅞-in. thick, are held to extremely close parallelism to maintain maximum linear contact. Inner sleeves



and center plate are keyed to pinion shaft to insure positive rotation under all conditions. Stationary plates are ground on OD for slip fit in the housing, with bores providing proper clearance around inner sleeves.

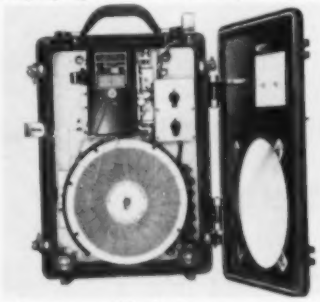
Machined bronze retainers contain four ½-in. diameter rollers in each of sixteen slots. Three rollers are ½-in. long; the fourth, ⅜-in. in length, is staggered to equalize distribution of wear. *Rollway Bearing Company.*

Circle number (43) on reply card.

Stainless Steel Valves. A new line of "ALL 316" stainless steel valves for corrosive gases and liquids is now available in ⅛, ¼, and ⅜ in. pipe sizes with ports from 1/16 to ¼ in. Main feature is having only 316 stainless steel and Teflon in contact with the medium flowing through the valve, while maintaining the packless feature. The valves are normally closed, angle pattern with coils unconditionally guaranteed. Greenclad, waterproof molded coils are used for temperatures to 250 F and silicone insulated coils for higher temperatures. *J. D. Gould Company.*

Circle number (44) on reply card.

Portable Recording Millivoltmeter. A new self-contained, portable millivoltmeter recorder for survey work has been announced. The instruments incorporate a wide variety of ranges and can thus be used to study practically any condition encountered in survey work which involves the measurement of voltage and current, such as in corrosion surveys. The low ranges are used chiefly for current, employing a standard shunt, or for meas-



uring the millivolt drop on an underground pipe or cable, of known resistance. The millivoltmeter recorders are offered with movement sensitivities of either 2000 or 10,000 ohms per volt. Each instrument is equipped to measure over 8 ranges. Instrument can be used for long term continuous records, as it can be left unattended for up to one week. *The Bristol Company.*

Circle number (45) an reply card.

New Flow Divider. New Products has added a new and larger flow divider to its line. Unit is designed to meet the requirements of equipment needing better control of the higher pressures characteristic of larger equipment. It has an adjustment device which can decrease or increase the flow on the controlled flow side to the rate of flow in proper proportion to meet the requirements of the job, and a built-in relief valve that bypasses oil back to the sump when the peak pressure setting of the secondary flow is reached. This setting may be lower than the main circuit setting. The excess flow need not be confined to high pressure problems. It can also serve for such low pressure jobs as charging a torque converter or in lubrication. Flow divider permits 2 simultaneous operations from one pump and divides the flow in any desired proportion. *New Products Corporation.*

Circle number (46) on reply card.

Forged Safety Tools. A forged, non-magnetic, non-corrosive and spark-resistant line of safety tools is now being offered. They will replace the standard cast metal safety tools in cases where quantity production permits. The line includes adjustable and box wrenches, pliers of various

types, pneumatic tools, air hammer chisels and air hammer points. Special Ampco aluminum bronze alloys have been selected to provide most satisfactory service for each type of the new forged tools. All those fitted with wooden handles have a special vacuum cup grip to prevent slippage. *Ampco Metal, Inc.*

Circle number (47) on reply card.

Stainless Steel Ball Valve. A new Type 316 stainless steel ball valve has been added to the Rockwood ball valve family. It comes equipped with Teflon seals and trim, has low pressure sealing, is easy to operate, and the stem repacking can be done without removing the valve from the line. Handle can be put on in 8 different positions. Valve is full round flow and opens and closes with a quarter turn. Available in ⅜ to 2-in. sizes. *Rockwood Sprinkler Company.*

Circle number (48) on reply card.

Liquid Transfer Case. A new type of metering Liquid Transfer Case has been designed. Vessel combines the features of both the Liquid Transfer Case and the Vol-U-Meter to provide the highest accuracy possible in the metering of liquids during transfer from low pressure to a higher pressure zone. The method of transferring the liquid is by gas pressure. The design of the vessel incorporates the shape of the Vol-U-Meter and its liquid level controls. In operation, liquid flows by gravity into the LTC-Vol-U-Meter vessel. When the liquid reaches the upper dumping level the liquid level control pilot closes the liquid inlet valve and opens the liquid outlet valve. Simultaneously, the pilot closes the outlet gas valve and opens the inlet gas valve. This allows higher pressure gas to displace or transfer the liquid to the higher pressure zone. When the liquid reaches the low level, the control pilot closes the liquid discharge valve and opens the liquid inlet valve, and simultaneously closes the inlet gas valve and opens the outlet gas valve. This allows the liquid to accumulate until it reaches the upper dumping level, completing a cycle which is registered on a counter or recorder.

The new model, the CV-LTC Liquid Transfer Case-Vol-U-Meter combination, is specifically designed for use where maximum metering accuracy is needed. *Oil Metering and Processing Equipment Corporation.*

Circle number (49) on reply card.

New Stair Tread. A precision-cast aluminum stair tread that combines safer footing for industrial workers with long-term maintenance savings for plant managers has been placed on the market. Designed for use in industries where stairs are subject to extreme weathering or corrosive atmospheres, the aluminum die-cast tread utilizes a slip-proof abrasive nosing. Stair tread answers the demand for a step which requires no costly protective coatings. A special aluminum alloy insures high corrosion resistance and strength, to afford long maintenance-free life. Dirt won't collect in the rounded, joint-free corners. Because the grating is cast in one piece, concentrated loads are distributed more evenly over all bearing bars. *Aluminum Company of America.*

Circle number (50) on reply card.

New Mobile Crane. Wagner-Morehouse is now in production on their new Rolahoist Model 25, Mobile Crane. This unit has a rated lifting capacity of 50,000 lb with hook 4½ ft ahead of the blade. Hook can be extended out to 16 ft ahead of the blade at which point the lifting capacity is 10,000 lb. Crane is flexible and mobile on or off the highway. A 1-man operation, it has 3 speeds forward and reverse, and can attain a maximum speed of 35 mph. Compact in design, it is only 8 ft 6 in. high permitting loading on a

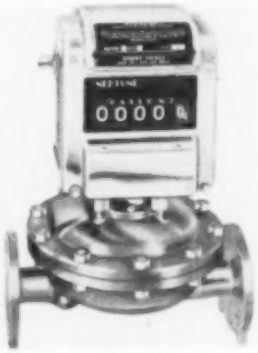
semi-trailer for extensive travel without violating legal height limitations. Crane has been designed to assemble a complete oil well drilling rig. *Wagner-Morehouse, Incorporated.*

Circle number (51) on reply card.

New Visual Aid Product. Spray-Vue, a new plastic slide to fit any standard projector, is the latest price-trimming device in the slide projection field. Spray-Vues have one frosted surface on which art work is directly applied, either by using Spray-Vue's special colored pencils or by typewriter. Slide is then fixed with a coat of Spray-Vue lacquer. Frosted surface disappears and the finished slide is completely transparent. Projection quality equals that of glassbound photographic slides. Spray-Vue combines high quality with low cost. Complete kits including slide frames, colored pencils and spray are offered. Spray-Vues are made in the 3 standard sizes, 3¼ by 4 in., 2¼ by 2¼ in., and 35 millimeter. Sizes are also available for the 7 and 10 in. overhead projectors. *Spray-Vue Enterprises, Inc.*

Circle number (52) on reply card.

Stainless Steel Liquid Meter. Based on the Neptune positive displacement principle, with only 1 moving element exposed to the liquid, this new meter makes it possible to obtain close metered control over corrosive solutions and chemicals which must be kept pure. Virtually immune to chemical attack, the meter



will maintain its high accuracy over long periods of service in batch mixing and general process work. By measuring the liquids inside the pipe it eliminates many of the hazards of handling corrosive liquids. Also important in many applications, this meter ends processing problems caused by metal pick-up or contamination of liquids being metered. The gear train is mounted outside the meter casing and is completely isolated from the liquid. Because of this, the meter has only one moving part exposed to the metered liquid. This means less chance for inaccuracies caused by corrosion or corrosive wear of gears, pistons, or other complicated mechanisms. There is no need to drain and flush the meter for periodic shut-downs just to protect the gearing. *Neptune Meter Company.*

Circle number (53) on reply card.

Panel Mounted Electrolytic Hygrometer. This new unit automatically and continuously measures water concentrations in vapor samples with a 5 percent accuracy in the difficult 0-1000 ppm range in temperatures up to 100 C. The Hygrometer controls corrosion, product purity and process efficiency. Analysis is performed by continuously passing a sample gas stream through a special analytical element that absorbs and electrolyzes all moisture present in the stream. The current required for this electrolysis is a precise measurement of the amount of water present. Incorporated in the Hygrometer is an alarm system that can be set for any point in the instrument's range. A standard potentiometric recorder or recorder-controller, 10 or 50 millivolt, can be operated from the Hygrometer output, making possible the continuous monitoring of water vapor in a plant process stream. *Process Instruments Division, Beckman Instruments Inc.*

Circle number (54) on reply card.

Laboratory Tanks. A new line of standard size, polyethylene laboratory tanks ¼ in. thick, and measuring 9 in. by 9 in. by 9 in., is now available as an off-the-shelf item from the American Agile Corporation. Typical applications for the tanks include storage of acids, developing solutions and other types of corrosive media in either liquid or solid form. Price is $34.65 each. *American Agile Corporation.*

Circle number (55) on reply card.

Nylon Fiber Batting. A new type of self-supporting batting made of nylon fibers has characteristics useful for thermal insulation, liquid and gaseous filtration, and vibration and shock absorption. As a filtering medium, different degrees of separation can be achieved by using different denier fibers in the fabric or by using blends of deniers. As a vibration absorber, tests show that a ¼-in. thick piece of the new material will absorb virtually all of the vibrations induced into a table while unmounted objects produce severe surface and lateral motion. As a shock absorber, the material seems to have desirable advantages because of its ability to soften an impact while recovering to its normal shape without undue force. Fabric batting possesses all of nylon's properties including being anti-fungus, anti-mildew, rapid drying, and resistant to alkalies and most acids. Since it will withstand continuous temperatures of 300 F, it can be laminated or stitched by a process utilizing heat treatment. It is non-allergic, light in weight, dimensionally stable under extreme conditions of cold and of heat up to the melting point of nylon itself. Material is called Ny-Sul-Loft. *Star Woolen Co.*

Circle number (56) on reply card.

Stops Sludge. Under stop-and-go driving conditions, harmful sludging of automotive engines may be halted by a new motor oil additive just being introduced, called Du Pont No. "7" M.O.A. Engineers maintain that the minimum driving distance required to heat oil to proper operating temperature is 10 miles. As ¾ of all trips are less than this, formation of sludge is relatively rapid in this kind of short haul service. *E. I. Du Pont.*

Circle number (57) on reply card.

STOP

SPRAY HEAD TROUBLES!

CONTROLLED SPRAY PATTERN WITH LOW PRESSURES!

Here is a spray head that operates efficiently on pressures under 5 pounds; is self cleaning and offers no resistance to the 1" water discharge. Result: Maximum cooling, minimum pumping costs, minimum clogging. Nylon rotor body, Graphite inserts, and Stainless Steel. Proved long life and low cost.

Write for Data.

N. C. STEARNS CO.,
Box 1234
Shreveport, Louisiana

"... does things others can't!"

STEARNS GYROSPRAY®

For Cooling Towers and Spray Ponds

NEW Literature

For more information on items described here in brief, use the handy reply card and circle the corresponding numbers

Personnel Selection and Training. Tests and other materials for use in personnel selection and training are described in the 1957 Industrial Catalog issued by Science Research. Catalog contains materials to use in selecting employees, improving employee performance, and reducing turnover. Also included are tests of intelligence, interest, and personality, as well as tests for measuring aptitudes and skills. *Science Research Associates.*

Circle number (58) on reply card.

Industrial Gas Chromatograph. A 4-page brochure describing the new Beckman Model 220 industrial gas chromatograph is now available. Model 220 has been designed for the continuous, automatic analysis of process streams, using a unique sampling valve and timing system. Samples are automatically extracted from the stream at intervals of 5 minutes to a half hour and accurately analyzed for up to 8 critical components. The results are presented as a bar graph on a standard strip recorder. *Process Instruments Division, Beckman Instruments, Inc.*

Circle number (59) on reply card.

Valves and Pipe Fittings. A new 16-page illustrated bulletin which describes Walworth polyvinyl chloride (PVC) valves and fittings has been issued. Bulletin presents application tables on the performance of normal impact PVC and high impact PVC valves and fittings for handling about 315 different fluids that attack other materials. A cutaway of a PVC Y-globe valve plus text details 9 design features for long-time control of corrosive fluids. Four tables give data on physical properties, recommended working pressures and effect of temperature on working pressure. Walworth's PVC fittings for threaded and welded pipe are shown in line drawings with dimension and weight information for each. The bulletin concludes with installation and assembly guides for PVC piping systems. *Walworth Company.*

Circle number (60) on reply card.

Two Glycols From Carbide. Diethylene glycol and triethylene glycol are discussed in a new 16-page data folder. It presents data on physical and physiological properties, specifications, shipping containers, constant-boiling mixtures and applications. The data folder contains 15 easy-to-read charts showing physical properties of diethylene and triethylene glycols. Diethylene glycol and triethylene glycol are important as intermediates for resins and plasticizers. *Carbide and Carbon Chemicals Company, a division of Union Carbide and Carbon Corporation.*

Circle number (61) on reply card.

Pipe Fabricating Operation. "How Piping is Fabricated" is the title of a new brochure. It shows how Flori Pipe Company and Houston Pipe & Steel, Inc., subsidiaries of the Sparton Corporation, combine their facilities and knowledge on piping fabrication. Brochure photographically illustrates equipment, materials and processes. *Flori Pipe Company, a subsidiary of the Sparton Corporation.*

Circle number (62) on reply card.

Zyglo and Zyglo-Pentrex. New booklet includes complete information on fluorescent penetrant materials and fluorescent penetrant testing. It lists the best selection of fluorescent penetrant materials and techniques for any individual testing use. Because Zyglo and Zyglo-Pentrex are widely used wherever non-magnetic materials are manufactured or tested during overhaul, this booklet should be helpful in selecting and controlling the best test for each usage, and in selection of the test which will be the most economical in use, consistent with the requirements of the test to be performed. Booklet also contains a first in the use of the new fluorescent offset printing inks to represent the fluorescent indications of defects shown by Zyglo and Zyglo-Pentrex. Fluorescent indications have extreme advantages in speed and sensitivity when testing under Black Light. *Magnaflux Corporation.*

Circle number (63) on reply card.

Expansion Joints. Rubber, Neoprene and Teflon-lined expansion joints, their construction, sizes and uses are explained in a new bulletin. It describes the characteristics and limitations of 7 styles of expansion joints and flexible couplings, namely, spool-type expansion joints, rectangular-type joints, U-type joints, all-Teflon expansion joints, all-Teflon flexible couplings, full-face Teflon lined rubber expansion joints, and expansion joints for use on piping and flanges. *The Garlock Packing Company.*

Circle number (64) on reply card.

Pocket-Size Slide Chart. A new pocket-size slide chart on machining stainless steels is new available. Chart contains information on how to machine the popular grades of stainless. On one side it gives concise data on turning, drilling, tapping, threading, milling and reaming operations. It tabulates speeds and feeds, and gives special notes on drilling, tapping, lubrication and welding. The other side of the chart shows relative workability of stainless steels in a wide variety of operations including blanking, deep drawing, stamping, forging, heading, roll threading, welding, etc. An inserted slide moves to show the machining data desired. *The Carpenter Steel Company.*

Circle number (65) on reply card.

Petroleum Processing Plants. New bulletin describes the complete engineering and construction services Blaw-Knox provides for the petroleum industry. The 28-page brochure lists a broad line of refining processes which the company offers. Also illustrated are numerous types of units designed and engineered for firms in the industry. *Chemical Plants Division, Blaw-Knox Company.*

Circle number (66) on reply card.

Titanium Metal Pipe and Tubing. This new technical data folder discusses the seamless titanium metal pipe and tubing produced by the Tubular Products Division. It presents size range, tolerances, and a description of the mechanical, physical and working properties of the metal in tubular form. *The Tubular Products Division of The Babcock & Wilcox Company.*

Circle number (67) on reply card.

Engineering Instruments. A completely revised catalog of engineering instruments has been published. A number of new explanatory tables are a feature of the 72-page book. Tables make it possible to locate detailed information at a glance. Recent models of instruments are described in detail, as are many of the features of Gurley instruments. Some of the sections in Bulletin 50 are: Transits, levels, leveling and stadia rods, current meters, and water level recorders. *W. & L. E. Gurley.*

Circle number (68) on reply card.

New Technical Booklet. A conference paper presented at the 1957 winter meeting of the American Institute of Electrical Engineers, entitled "Polyethylene for Higher Voltage Cables," is available in booklet form. It contains detailed information on the development and use of polyethylene as an insulation and jacket material for power cables used on ac circuit voltages from 2300 through 33,000. Included are sections on polyethylene insulation and sheath characteristics; cable design, manufacture, and specifications; installation; price comparison; the use of polyethylene on cables rated higher than 15 KV; and the future of polyethylene as an insulation material. *Rome Cable Corporation.*

Circle number (69) on reply card.

Meter Selection. Neptune Industrial Metering Bulletin 566 has been revised to help the process engineer select the best meter-register combination for any industrial liquid metering job. Arranged in comparative chart form, subjects covered include: How meters save; list of liquids that can be handled; construction details; register types; and sizes of meters. Accessories, installation directions and numerous application photographs are also included. *Neptune Meter Company.*

Circle number (70) on reply card.

Salaried Employees. The National Association of Manufacturers has issued a new study entitled "Satisfying Salaried Employees," which it describes as a practical manual for building better relations with all categories of white-collar people. The study covers 4 areas which the NAM says hold the answers to job satisfaction in the office and laboratory. They are status and recognition, compensation, communication, and supervision. The 64-page booklet sets forth sound practices in each area. It is designed to help employers find out what salaried workers want in their job, and then point up ways and means of providing these job satisfactions. *National Association of Manufacturers.*

Circle number (71) on reply card.

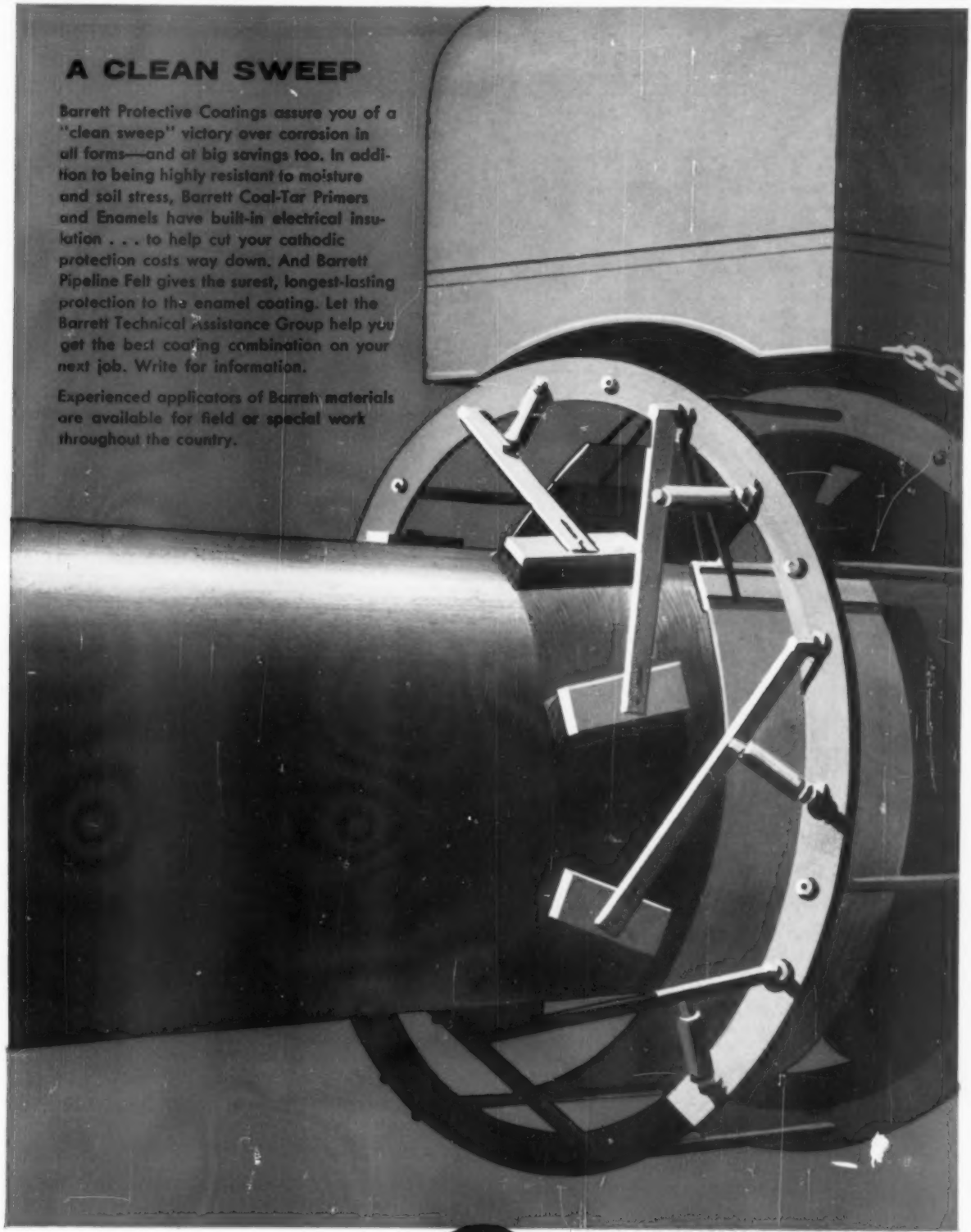
New Marine Catalog. A new marine catalog, containing data on an extensive line of flexible hoses and reusable fittings for the marine industry, has been released. The 54-page book is fully illustrated and includes planning information, bend radii data, pressure and vacuum data. Complete specifications are listed on hose and fittings for use with diesel fuel, lube oil, hydraulic fluid, LP-Gas, Freon 12, and steam, salt, fresh, and drinking water lines. *Aeroquip Corporation.*

Circle number (72) on reply card.

A CLEAN SWEEP

Barrett Protective Coatings assure you of a "clean sweep" victory over corrosion in all forms—and at big savings too. In addition to being highly resistant to moisture and soil stress, Barrett Coal-Tar Primers and Enamels have built-in electrical insulation . . . to help cut your cathodic protection costs way down. And Barrett Pipeline Felt gives the surest, longest-lasting protection to the enamel coating. Let the Barrett Technical Assistance Group help you get the best coating combination on your next job. Write for information.

Experienced applicators of Barrett materials are available for field or special work throughout the country.



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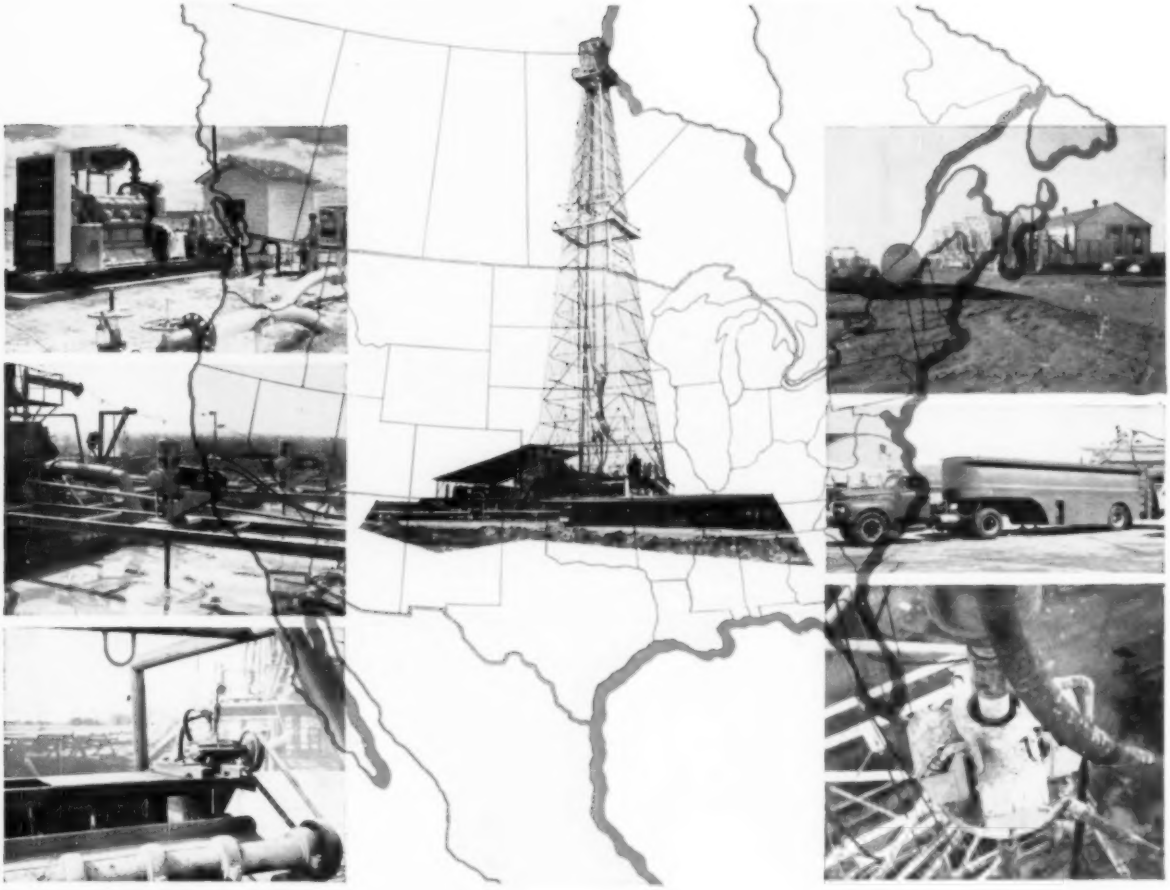
BARRETT DIVISION, Allied Chemical & Dye Corporation, 40 Rector Street, New York 6, N.Y. In Canada: The Barrett Company, Ltd., 5551 St. Hubert Street, Montreal, Que.

Allied Chemical

OVER 100 YEARS OF EXPERIENCE



Wherever you find Oil or Gas you'll find BERRY® HYDRAULICS

...on fan drives in gas compressor stations
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There are exceptions, but generally speaking, the advantages of Berry Hydraulic pump motor drives are known and profitably employed by oil and gas men everywhere. And small wonder!

This rugged power package produces smoother, safer, entirely foolproof power transfer . . . together with infinitely variable speed and finger-tip control. No matter where Berry units are put to work . . . drilling, production, processing or transmission . . . they add up to dollars back in the till.

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Oliver Building
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PIPELINE DEVELOPMENTS ★ ★ ★

Roundup of Planned and Proposed Construction

The following tables list the company, mileage, pipe size, and location of proposed pipeline projects — crude, products, and natural gas — reported to *The Pipeline Engineer*. Company addresses are given when known.

CRUDE LINES

Name of Company	Miles	Size	Location
Act Oils, Toronto, Ontario	350	—	Line from Peace River area in British Columbia, thru Pine Pass to Prince George, westward to Bella Coola terminus on Pacific Coast
Atlantic-Cities-Service-Continental-Gulf-Phillips-Texas-Sinclair	Approx 385	26	Midland, Texas, area to Houston
Cape Pipe Line Company Philadelphia, Pennsylvania	200	—	Large diameter from Delaware Bay to Greater Philadelphia area refineries
Lakehead Pipe Line Company, Inc. Toronto 1, Ontario, Canada	80	26	Loop from Clearbrook, Minnesota, to Superior, Wisconsin
North-West Oil Pipelines Company	210	—	Wilhelmshaven, on the North Sea, to industrial Ruhr area of West Germany
Northwest Pipe Line Corporation Salt Lake City, Utah	350	8–10	Four Corners area to Salt Lake City, Utah
Offshore Gathering Company Houston, Texas	364	20	Gulf of Mexico from Sabine Pass to Mississippi River
Royal Dutch Shell Group and Others The Hague, Netherlands	870	30	Marseille, France, to Rotterdam, Holland, and Antwerp, Belgium
Royal Pipe Lines, Ltd. Regina, Saskatchewan, Canada	288	Var.	Cantuar area fields to Glenavon
Salt Lake Pipe Line Company Salt Lake City, Utah	100	10	Additions to Rangely, Colorado-Salt Lake City line
Sinclair Pipe Line Company Independence, Kansas	150	20	Teague to Houston, Texas
Southern Kansas Pipe Line Company	310	6, 10	10,000 bbl per day line from Greenwood pool, near Colorado line, thru Liberal to Arkansas City, Kansas
Texas-New Mexico Pipe Line Company Houston, Texas	515	16	Extension from Jal, New Mexico, pump station to Four Corners area
Trans-Border Pipe Line Company	110	—	Skagway, Alaska, to Whitehorse, Yukon Territory

PRODUCTS LINES

Name of Company	Miles	Size	Location
El Paso Natural Gas Company El Paso, Texas	96.0	8	Gallup to Blanco Plant, New Mexico
	290	Var.	Additional line on existing system in Texas, New Mexico, Arizona
El Paso Natural Gas Products Company	250	6	Odessa, Texas, to El Paso
Equitable Gas Company and Subsidiaries Pittsburgh, Pennsylvania	100	4–5	Maytown, Kentucky, to Institute, West Virginia
Great Lakes Pipe Line Company Kansas City, Missouri	84	8	Eau Claire, Wisconsin, laterally from a point on existing lines south of St. Paul, Minnesota
	68	12	To Chicago from juncture of Great Lakes' lines with Badger system. Will supplant existing 6-in. line
	140	8	Connect terminals between Minneapolis and Superior, Minnesota
	34	12	Tulsa to Barnsdall, Oklahoma, loop
	14	8	Coffeyville to Independence, Kansas
	11	8	Line between point near Donahue, Iowa, pump station to Mississippi River terminal at Bettendorf, Iowa
Northwest Pipeline Corporation Salt Lake City, Utah	350	8–10	Four Corners to Salt Lake City, Utah
Ohio Oil Company Findlay, Ohio	—	—	Common carrier line from Wood River, Illinois, to Chicago
	—	—	Connecting line from Robinson, Illinois, refinery to new line
Salt Lake Pipe Line Company Salt Lake City, Utah	80	8	Additions to Boise, Idaho, to Pasco, Washington, line
Service-Continental-Sinclair-Phillips	550	—	Salt Lake City, Utah, to Spokane, Washington
Texas Eastern Transmission Corporation Shreveport, Louisiana	1168	16–20	Conversion of "Little Inch" between Beaumont, Texas, and Moundsville, West Virginia
Union Oil Company of California	815	—	Shale Oil Plant, Rifle, Colorado, to Los Angeles area
Winnipeg & Central Gas Company Winnipeg, Manitoba, Canada	210	6	U. S.-Canadian border to Winnipeg

There's MORE

from Allis-Chalmers...

Dependable Power

for the Petroleum Industry

MORE continuous processing results from the many features of Allis-Chalmers deep-rib, chemical-type motors in a variety of refinery and pipeline uses.

Here are only a few of the reasons why these motors "pay off" in petroleum applications:

MORE cooling surface, more iron and copper content—all contribute to longer Allis-Chalmers motor life in dirty, hot or corrosive locations.

MORE drainage provisions result from condensation-eliminating sump and drain system in motor yoke. Moisture can't collect to short out this motor.

MORE corrosion-resistance is designed into hardware. All bolts are hexhead type and Parkerized to fight off rust.

Rib-Type MOTORS 1 to 100 hp

Rib construction is available in Allis-Chalmers motors from 1 to 100 hp. As a new machinery component or as replacement, specify Allis-Chalmers. Contact your A-C district office or distributor, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wis.

ALLIS-CHALMERS

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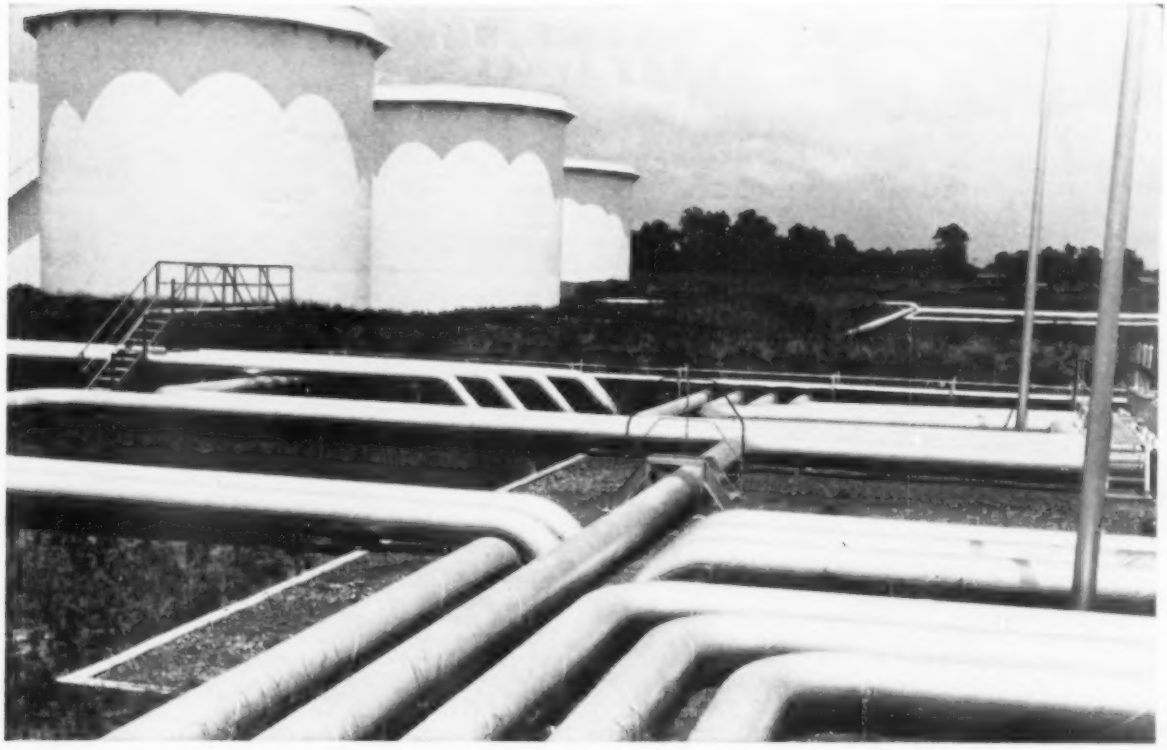

ARMCO WELDED STEEL PIPE SAVES YOU MONEY 3 WAYS

LONG, UNIFORM LENGTHS

Uniform lengths, up to 50 feet without a circumferential weld, mean fewer joints, faster assembly, and easy, accurate computation of joints required.

CHOICE OF 20 DIAMETERS

Wide range of diameters makes it unnecessary to buy more capacity than is needed.

CHOICE OF 10 WALL THICKNESSES

You can select the correct wall thickness for the job without buying costly excess metal.

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Write for more data. Armco Drainage & Metal Products, Inc., Welded Pipe Sales Division, 4847 Curtis Street, Middletown, Ohio. 201 KOME Building, Tulsa, Oklahoma. Subsidiary of Armco Steel Corporation. Export: The Armco International Corporation.

Where Armco Pipe is used in the Oil and Gas Industries

1. **Natural Gas and Natural Gasoline Divisions**
   a. Gas gathering lines
   b. Natural gasoline plant piping
   c. Residue gas lines
   d. Gas transmission lines
2. **Oil Refining Division**
   a. Stock lines
   b. Low pressure steam lines
   c. Vapor collection lines
   d. Waste product lines
3. **Oil Producing Division**
   a. Casing
   b. Oil lines
4. **Miscellaneous uses (all divisions)**
   a. Conduit or casing pipe
   b. Pipe piles, pile shells
   c. Water well casing
   d. Water supply lines
   e. Cooling water systems

ARMCO WELDED STEEL PIPE

ARMCO

GAS LINES

Name of Company	Miles	Size	Location
Arkansas Louisiana Gas Company	300	—	Main and gathering lines Louisiana-Texas Gulf Coast
Andes Pipeline Corporation	500	12	Villamontes, Bolivia, to Antofagasta, Chile
Cities Service Oil Company	70	—	Gas gathering system on the Roberts Ranch, Midland, Texas
Bartlesville, Oklahoma	115.6	Var.	Montgomery, Allen, Anderson, Franklin, Miami, Johnson, Wilson counties, Kansas
Coastal Transmission Corporation	574	22–26	McAllen, Texas, to Baton Rouge, Louisiana
Dallas, Texas	414	Var.	Gathering lines in Rio Grande Valley, Texas
Colorado Interstate Gas Company	345	30	Kit Carson, Colorado, to Beatrice, Nebraska
Colorado Springs, Colorado	100	24	Springfield to Pueblo, Colorado
	24	24	Greenwood to Panhandle-Kit Carson loop
	109	20	Loop from Fourway, Texas, to Springfield, Colorado
	106	24	Loop from Springfield to Kit Carson, Colorado
	10	16	Keyes field, Oklahoma, to mainline
	6	10	Tablerock field, Wyoming, to mainline
	12.0	12–22	Additions in Texas Panhandle fields
El Paso Natural Gas Company	8.3	26	Loops to California mainline in Yuma County, Arizona
El Paso, Texas	22.5	20	South Andrews field booster station to plant
	8.5	16	Shell plant to Goldsmith station
	290	—	To deliver additional gas to three California customers. New gas to come from San Juan Basin and Panola and Permian Basin fields in Texas.
Kansas-Nebraska Natural Gas Company	61.3	Var.	Gathering lines from Camerick field to Liberal, Kansas
Phillipsburg, Kansas	10	10	Grand Island to Fullerton, Nebraska
	10	8	Loop from Grand Island to Fullerton, Nebraska
	11.5	12	Replacement from Scott City to Oakley, Kansas
	1.2	6	Additions to system in Nebraska
	9	8	Lexington to Central Nebraska Public Power Electric Plant
	14	16	Replacement from North Platte to Maxwell, Nebraska
Michigan Wisconsin Pipe Line Company	31	4–6	Looping in Michigan and Indiana
Detroit, Michigan			
Midwestern Gas Transmission Company	1112	12–24	Mainline from U. S. Canadian border near Emerson, Manitoba — Noyes, Minnesota, to Portland, Tennessee
	648	3–18	Laterals of mainline to serve communities in Minnesota, North Dakota, and Wisconsin
Natural Gas Pipe Line Company of America	38	36	Joliet to Elgin, Illinois
Chicago, Illinois	405	36	Beaver County, Oklahoma, to Joliet, Illinois (loops)
	25	—	Gathering line from Quinduna field, Roberts County, Texas, to point on existing line
	91	30	Loops in Nebraska, Kansas, Oklahoma
Northern Natural Gas Company	28	24	Ogden to Redfield storage area, Iowa
Omaha, Nebraska	168	20	St. Paul-Minnesota to Duluth, Minnesota, and Superior, Wisconsin
	100	20–24	Savannah Creek field, Alberta, to Alberta-Montana border near Cardston, Alberta
Northern Plains Natural Gas Company (subsidiary of Northern Natural Gas Company)	1100	26	Alberta-Montana border to Minneapolis, Minnesota
Omaha, Nebraska			
Offshore Gathering Company	364	30	Offshore gas line in Gulf of Mexico from Sabine Pass to Mississippi River
Houston, Texas			
Pacific Gas & Electric Company	200	12	Glenn and Tehama counties to Eureka and Arcata, California
San Francisco, California			
Pacific Lighting Gas Supply Company	80	30	Coles Levee to Newhall, California
Los Angeles, California	2.1	16–20	Potrero to Newhall, California
	2.8	16	Lines in East Whittier, California
Tennessee Gas Transmission Company	100	—	New gathering lines in Texas and Louisiana
Houston, Texas	557	30	Mississippi River Delta south of New Orleans to Portland, Tennessee
	120	12,20,26	Kinder, Louisiana, south 68 miles into Gulf of Mexico
	332	24–30	Loops in Kentucky, West Virginia, Pennsylvania, Tennessee
	76	24	Coudersport, Pennsylvania, to Buffalo, New York
	299	Var.	Adding to existing systems in Ohio, Pennsylvania, Kentucky, Texas and Louisiana
Texas Eastern Transmission Corporation	690	30	Loop lines between Kosciusko, Mississippi and Uniontown, Penn.
Shreveport, Louisiana	105	30	Loop lines between Vidor station (Texas) and Kosciusko, Mississippi
	22	14	Lateral supply lines
Texas-Illinois Natural Gas Pipeline Company	59	20	Joliet to Volo, Illinois
Chicago, Illinois			
Trans-Canada Pipe Lines, Ltd.	2294	20–34	Winnipeg to Montreal and laterals
Calgary, Alberta, Canada			
Transcontinental Gas Pipe Line Corporation	13	24	Purchase lateral in Louisiana
Houston, Texas	28.5	16	Purchase lateral in Gulf of Mexico, off Louisiana Coast (7.5 mi. offshore)
	213	12–24	Purchase laterals in Texas
	42	36	Additional mainline looping
	16	30	Additional mainline looping
Westcoast Transmission Company, Ltd.	174	30	Line from Savannah Creek gas field, Alberta, to existing system

For lowest cost trenching . . .

New Model 774 Wheel Ditcher for the big jobs up to 5'6" deep, 30" wide. Ideal for pipeline work. Exclusive Hydra-Crowd allows infinite range of digging speeds to 31 ft. per min. Unique flexible connection between chassis and wheel. Floating differential. All-hydraulic spoil conveyor. Hydraulic controls.

Model 705-B Runabout for scattered jobs up to 4' deep, 10½" wide. 15 m.p.h. road speed. Exclusive vertical boom digs right up to obstructions, leaves no ramp. Hydra-Crowd permits infinitely variable crowding speeds from 0 to 16 ft. per min. Fluid coupling prevents shock loads.

choose the ditcher that's right for you

The first step in reducing ditching costs is to select the machine that meets your requirements. Ground conditions . . . digging range . . . travel speed between jobs—all are factors that change with varying trenching operations. That's why Barber-Greene builds *five* distinctively different ditchers, each with special features that give it unsurpassed performance in its field.

Model 711 for widely scattered jobs. 45 m.p.h. travel speed. Digs to 5' deep and 18" wide. One-man operation. Hydra-Crowd assures maximum crowding speed for every digging condition.

Model 702 for narrow trenches to 5" wide, 40" deep. Ideal for cable, conduit, or small pipe. Easily moved. Varidraulic drive gives finger-tip control of crowding speed from 0 to 20 ft. per min.

Model 44-C for heavy-duty trenching. It cuts to 8'3" deep, 24" wide. 15 digging speeds from 1 to 11 ft. per min., or available with Hydra-Crowd with infinitely variable speeds from 0 to 7 ft. per min.

Literature on request.

57-8-D

Barber-Greene BG

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Bucyrus-Erie 22-B Clamshell Speeds Pipeline Ditch Cleanout

When the Michigan-Wisconsin Pipeline Co. began construction on a natural gas line from Oshkosh to Waukesha, Wis., this Bucyrus-Erie 22-B clamshell was chosen for ditch cleanout work. Shown here just south of West Bend, Wis., it was one of five 22-Bs on the spread. These machines helped keep things moving at a steady clip through terrain consisting of sand, clay, muck and rock.

The 22-B is built to work efficiently under adverse conditions. Optional tractor-type crawler mounting provides extra clearance for safe travel over rocks, stumps and most other obstructions normally encountered. Tractor-type treads have deep grousers for sure traction in soft ground and for climbing steep grades. Special sealing helps protect track-roller bearings against damage from water, dust, dirt, and grime.

Bucyrus-Eries offer the type of performance *and dependability* that keep jobs moving on schedule regardless of obstacles.

For more information on the rugged, high-output features of Bucyrus-Erie cranes and excavators, see your Bucyrus-Erie distributor today.

385E57

BUCYRUS ERIE

SOUTH MILWAUKEE, WISCONSIN

Plantation's new 18" pipeline carries gasolines, kerosenes, diesel and fuel oils 327 miles from Baton Rouge, La., to Helena, Ala.

Blue Flag helps protect Plantation's new 18" pipeline against corrosion

By using glass fiber mat to reinforce the enamel coating, Plantation Pipe Line Co. helped give longer lasting protection against corrosion to its new line, tapping the Gulf Coast for southeastern markets. Blue Flag Pipe Wrap was used on approximately 100 miles of this project.

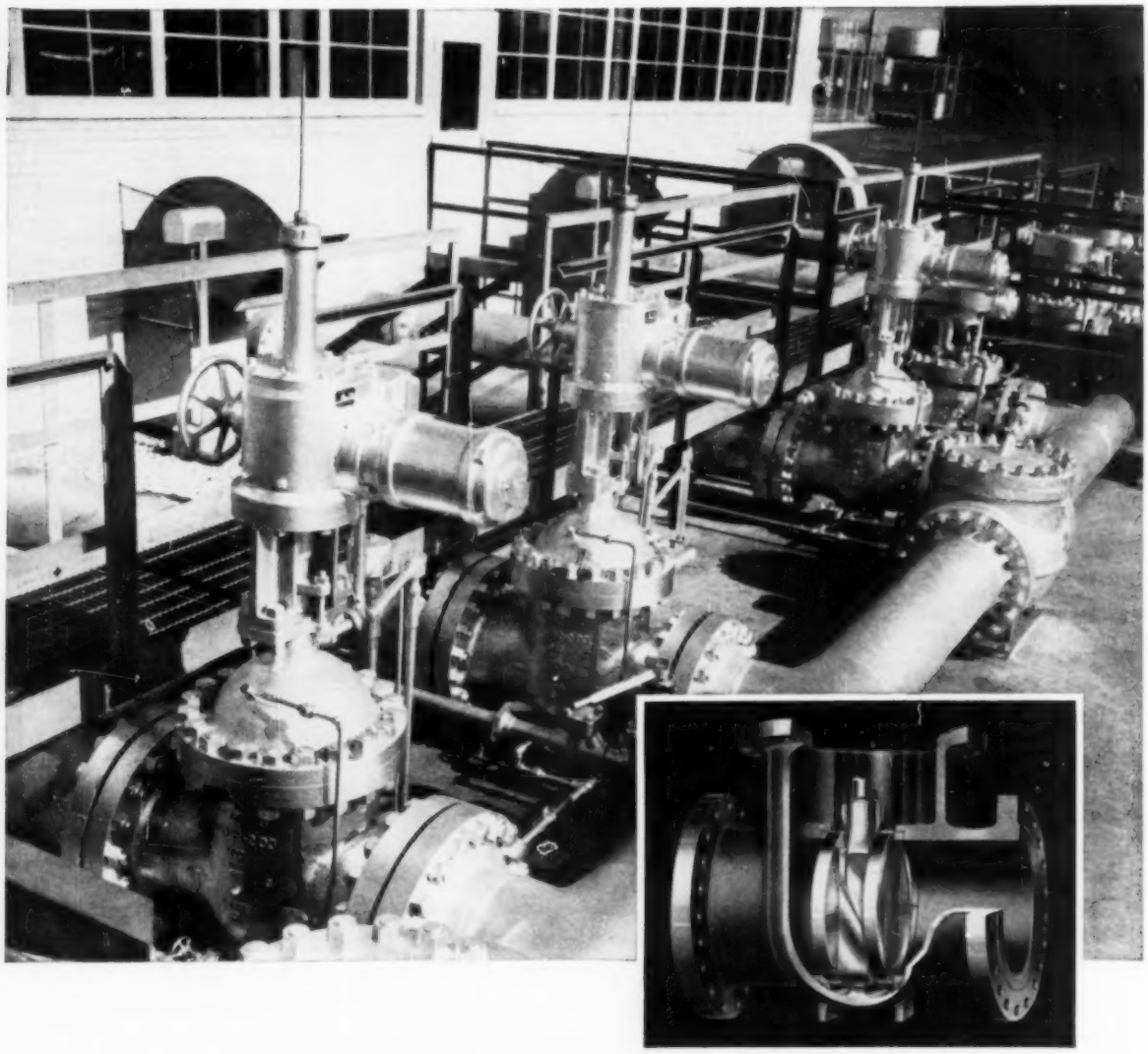
L·O·F Glass Fibers' Blue Flag guards pipelines against corrosion by strengthening protective enamel, and increasing its resistance to soil stress and backfill damage. Its uniform porosity allows enamel to bleed through quickly, lets trapped gas escape easily. Result: far fewer "holidays" and greatly increased pipeline service life. Cost: less than ½ of 1% of initial investment.

Blue Flag Pipe Wrap is made from inert glass fibers which resist the action of soil chemicals. And its high tensile strength virtually eliminates breakage in the field and resulting time loss.

For long-lasting pipeline protection at low cost, insist on Blue Flag reinforcing inner-wrap for your over-the-ditch and yard-wrapped pipe. Your nearest distributor gives fast delivery. For his name, or for full technical information, write today: *L·O·F Glass Fibers Company, Dept. 72-67, 1810 Madison Ave., Toledo 1, Ohio.*

L·O·F GLASS FIBERS

L·O·F GLASS FIBERS COMPANY · TOLEDO 1, OHIO



Why Darling revolving double disc gate valves mean . . .

permanent good behavior!

THE reason is very simple. These valves are different! They were designed with one objective uppermost—to be uneffected by the very conditions that lead to trouble in ordinary gate valves. And so it was that Darling came up with the fully revolving double disc, parallel seat principle. It minimizes friction and avoids wear concentration. It assures remarkably easy operation with self adjustment for positive closure. It automatically compensates for any valve body deflection.

The proved result is that these Darling valves consistently show superiority in service life, low maintenance, positive operation and trouble-free performance. Savings naturally result. Write for Catalog No. 57.

DARLING VALVES

DARLING VALVE & MANUFACTURING CO.

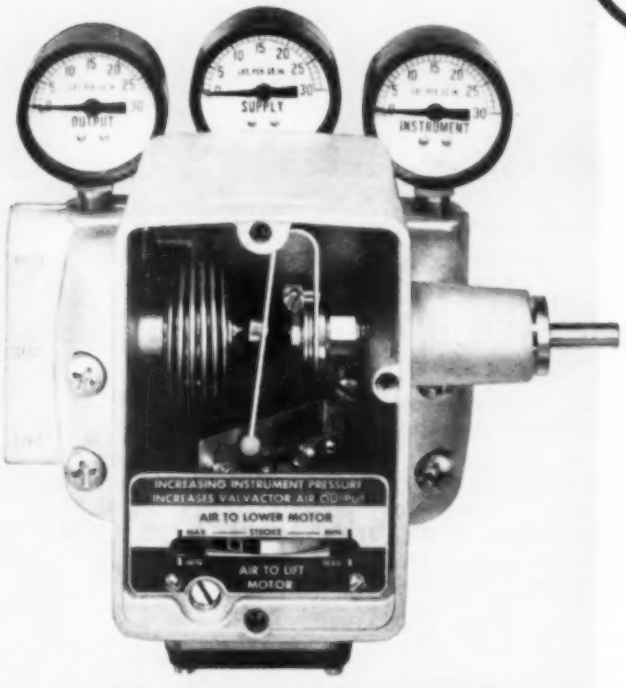
Williamsport 2, Pa.

Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ontario

NEW!

MOST UNIVERSALLY ADAPTABLE VALVE POSITIONER ON THE MARKET!

...the Foxboro Type C VERNIER VALVACTOR*



The Type C Valvactor's distinctive motion-balance principle of stem positioning eliminates loading effects of heavy fixed-stroke actuating springs. Note compactness — the simplest mechanical design of any valve positioner.

**Trademark of a precision valve positioner made by The Foxboro Co.*

Unique Flexibility Easily reversible in seconds. Sequencing by two simple adjustments.

Super Response Full air-pressure output to diaphragm motor on signal air-pressure change as small as ½ of 1% of signal span.

Extra Speed New, high capacity relay provides high speed positioning action.

Positive Positioning Direct, motion-balance feed-back assures instantaneous, pin-point positioning.

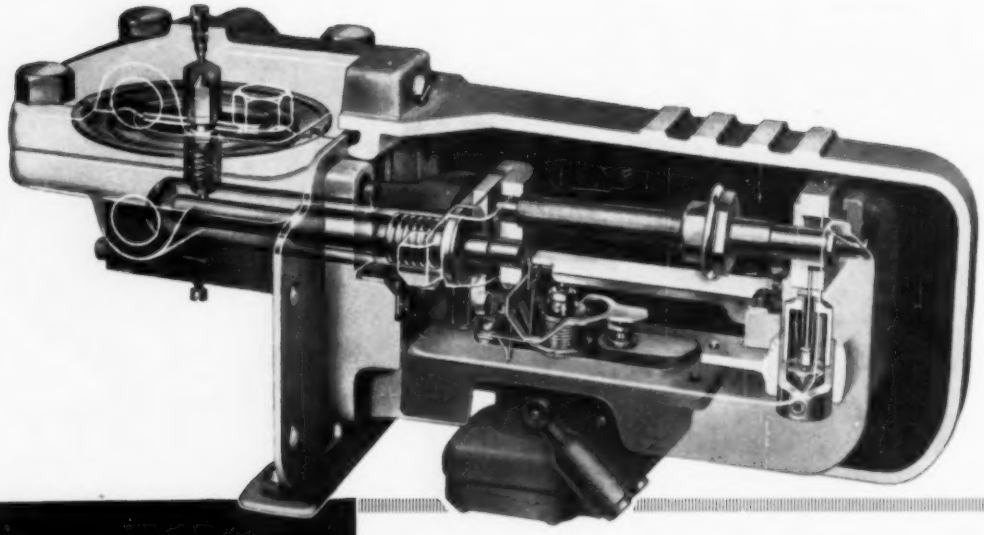
Now there's a positive-action, super-precision valve positioner that you can easily adapt to *any* diaphragm motor application — without exchange of parts! It's the Foxboro Type C Vernier Valvactor with unique motion-feedback.

The Type C Valvactor has a master setting disc which provides easy change of action as required by the control system, as well as easy reversal of Valvactor action for air-to-open or air-to-close control valves. Adjusting for limited stem travel is equally simple ... sequencing of several valves is a cinch!

The Valvactor is the ideal solution to such problems as stem friction, plug friction, valve motor and transmission line lag, and extreme process line pressure changes. And it requires practically no maintenance! Available with 3-gauge and by-pass manifold, or plain manifold. Write for full details.

The Foxboro Company, 386 Norfolk St., Foxboro, Mass., U.S.A.

FOXBORO
REG U S PAT OFF
VALVE POSITIONERS



For full-range control of flow and liquid level

...there are now three HONEYWELL *Differential Converter* models

1. *For measuring gas and water flows:* The new model has a range of 0-5 to 0-25 inches of water. It can also be adapted to the measurement of specific gravity of liquids in open tanks.
2. *For measuring liquid level in closed tanks:* One model has a range of 14 to 50 inches of water, with maximum suppression of 75 inches. Another model, with a range of 50 to 200 inches of water, has maximum suppression of 200 inches.
3. *For measuring flow and liquid level in open tanks:* Two models with ranges from 0-20 to 0-200 inches of water differential and 0-100 to 0-1000 inches.

A mercuryless remote pneumatic transmitter with a range that is continuously adjustable between 0-5 and 0-25 inches of water has just been added to the Honeywell *Differential Converter* line. Now you can choose a standard transmitter for any range from 0-5 to 0-1000 inches of water . . . a choice of ranges offered by no other manufacturer.

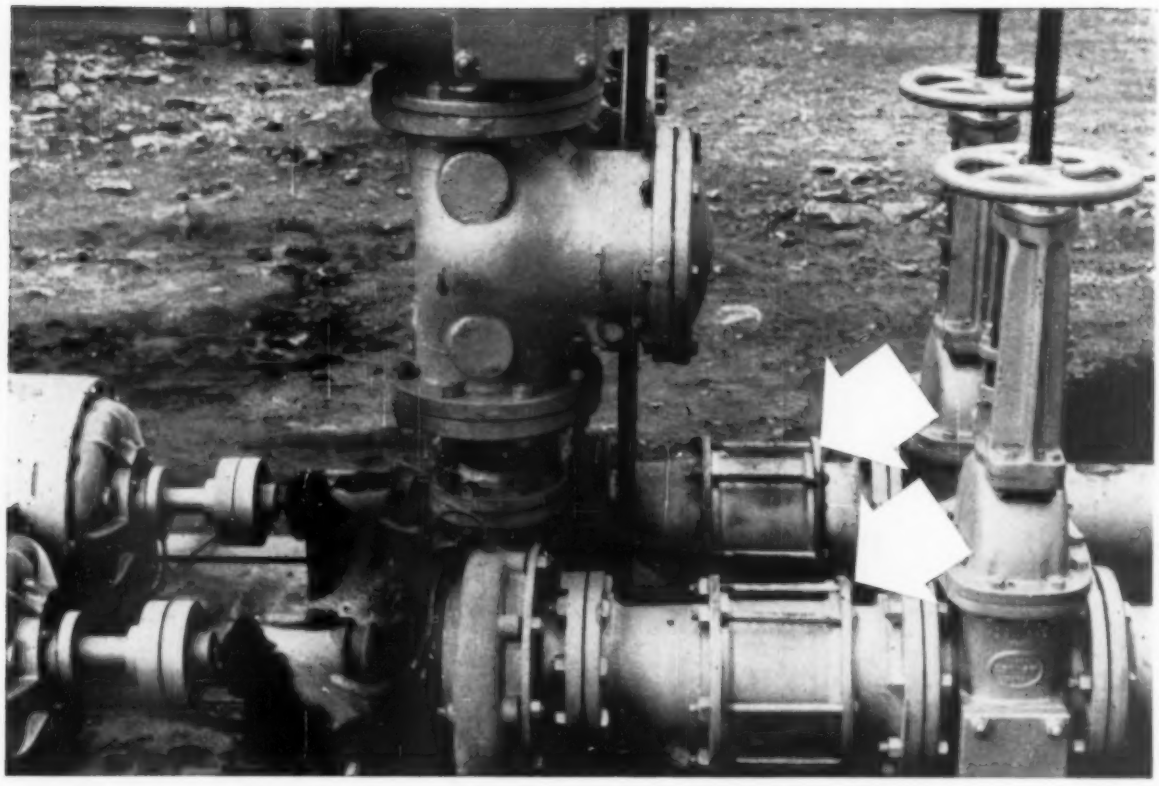
The *Differential Converter* measures gas and liquid flow or liquid level with accuracy within ±1% . . . and with rapid response, upscale and down. Range is continuously adjustable in the field, without parts change, and field calibration check is easily accomplished with weights. Air consumption is extremely low.

Compact and lightweight, these transmitters can be mounted anywhere. They're ideal companions for Honeywell *Tel-O-Set* miniature instruments. Call your nearby Honeywell sales engineer for details. He's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Phila. 44, Pa.—in Canada, Toronto 17, Ontario.

● **REFERENCE DATA:** Write for Bulletin 2280-1, "*Differential Converter* Liquid Level Transmitter"; Catalog 2321, "Flow Meters," and Specification 248, "*Differential Converter* Flow Transmitter."

MINNEAPOLIS **Honeywell**
BROWN INSTRUMENTS
First in Controls



Speed up installations and line repairs . . . the DRESSER way!

Dresser Couplings and Repair Products make short work of dozens of installation and maintenance problems. For instance:

Two man-minutes per bolt is all the time needed to install the Dresser Couplings shown above. They make vibration-absorbing connections that stay permanently tight. For fast connections and repairs of all types of transmission piping, Dresser Couplings and Long Sleeves are ideal. Complete size and pressure range.

To repair a porous weld, without shutting down the line, use a Dresser Porous Weld Clamp. Put it around the weld, draw up the bolts. It's that simple. Sizes 2″ through 31″.

For quick repairing of breaks, splits and holes in high pressure lines, use Dresser Split Repair Sleeves. No loose parts. No welding. Self-sealing end-gasket pressure increases as line pressure increases. Sizes 6″ through 24″ and larger.

For reinforcing welded joints, use Dresser Reinforcing Sleeves, made of best grade flange-quality steel plate. Vented against pressure build-up. Also available for coupled joints.

It always pays to stock Dresser Couplings and Repair Products. Buy them from your piping supplier or write us direct at the nearest address given below. Write today for catalog.

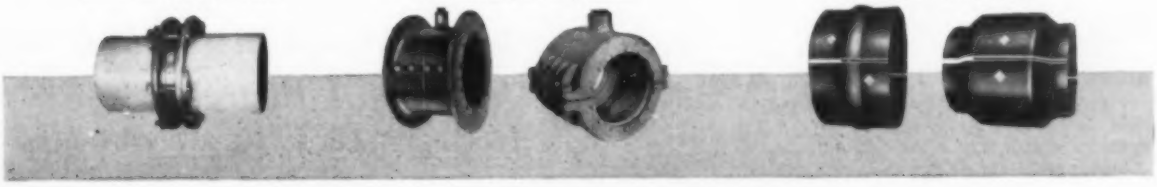
DRESSER®

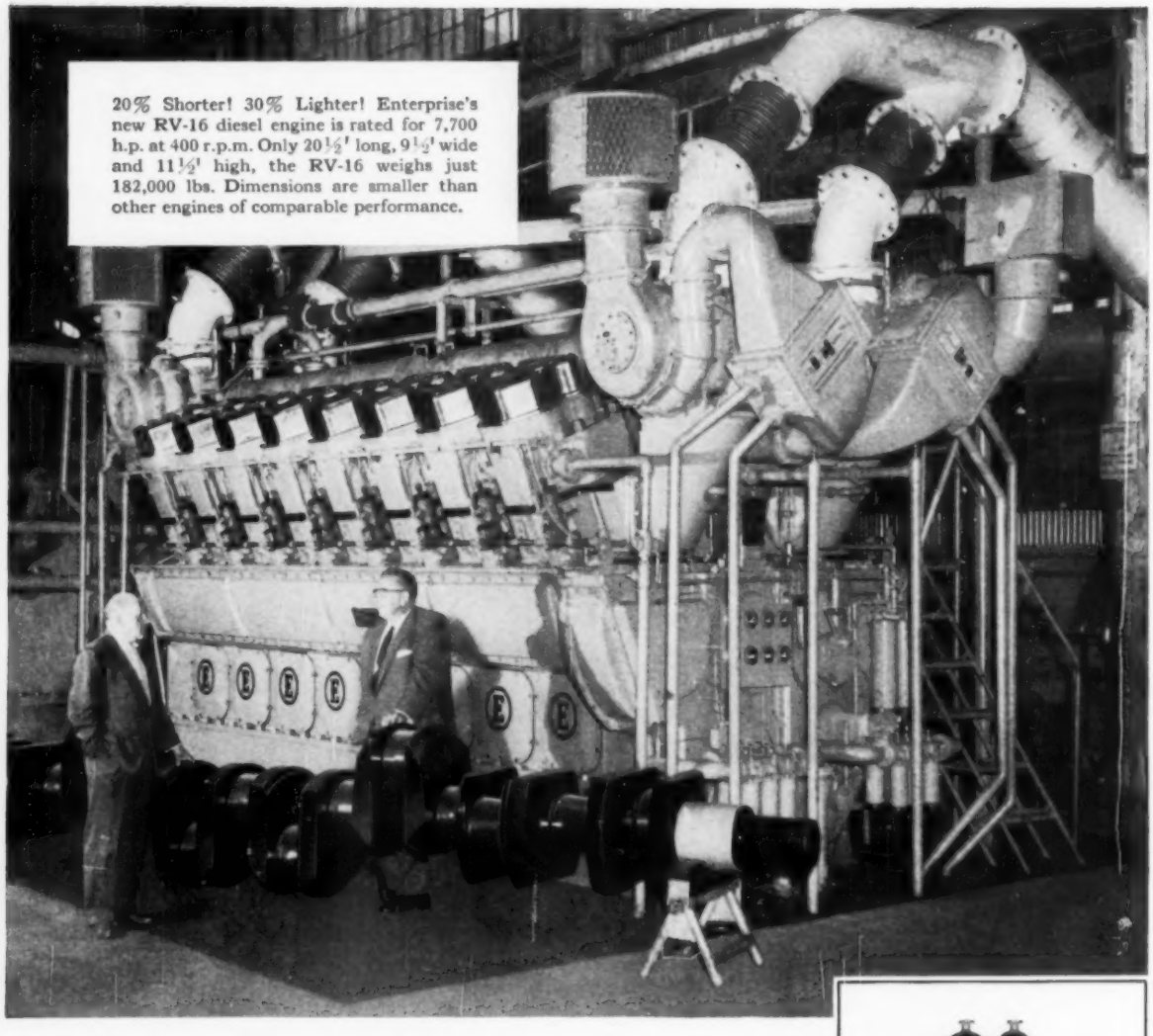
Dresser Manufacturing Division, 49 Fisher Ave., Bradford, Pa. Warehouses: 1121 Rothwell St., Houston; 101 S. Airport Blvd., S. San Francisco. In Canada: 1211 Bathurst St., Toronto; 1210 11th Ave., W., Calgary.

TO REPAIR POROUS WELDS

FOR BREAKS, SPLITS, HOLES

REINFORCING SLEEVES





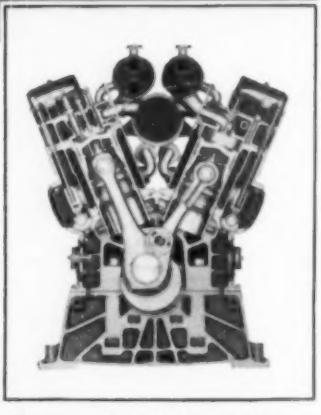
20% Shorter! 30% Lighter! Enterprise's new RV-16 diesel engine is rated for 7,700 h.p. at 400 r.p.m. Only 20½' long, 9½' wide and 11½' high, the RV-16 weighs just 182,000 lbs. Dimensions are smaller than other engines of comparable performance.

Enterprise Chooses KOPPERS Piston Rings Exclusively for RV-16

Prototype of a new line of industrial diesel engines, the RV-16, built by Enterprise Engine & Machinery Co., of San Francisco, is designed for such rugged operations as delivering main propulsion in towboats and seagoing freighters, or supplying power for pumping stations or electric generation.

As many other leading manufacturers have done, Enterprise has selected Koppers Piston Rings exclusively. Koppers wide range of types and sizes . . . variety of material selection . . . control of material quality . . . close tolerance performance . . . rigid standards of inspection—all contribute to Koppers leadership in the field of industrial piston and sealing rings, making Koppers the most dependable source of supply.

If you have a problem of ring application, avoid further needless expense. Take advantage of Koppers experience, research facilities and craftsmanship. Write for information today. KOPPERS COMPANY, INC., Piston Ring and Seal Department, 1706 Hamburg Street, Baltimore 3, Maryland.



Cutaway shows internal design of the RV-16

KOPPERS

AMERICAN HAMMERED
Industrial Piston Rings
Engineered Products Sold with **Service**

Say GASO and R-e-l-a-x

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No question, no doubt, no uncertainty when you specify GASO Pumps. Their 42-year record is relaxing assurance of everything you look for in pumps—adaptability to the job, capacity performance and low, low upkeep for unbelievably long periods of time. We are as close to you as our nearest distributor.

Newest member of the Gaso family—Fig. 3466 Horizontal Triplex Pump. A rugged 4" stroke high speed single acting plunger pump for moderate capacity, medium-to-high pressure service.

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GASO PUMPS
for every oil industry need

the INSLEY "pipeliner" ...a machine built for pipeline work

The Insley "Pipeliner" is the hard-working answer to the contractor's need for a machine especially designed for pipeline work . . . a machine with "built-in" durability and stamina that will withstand the severe operating conditions of cross-country pipelining.

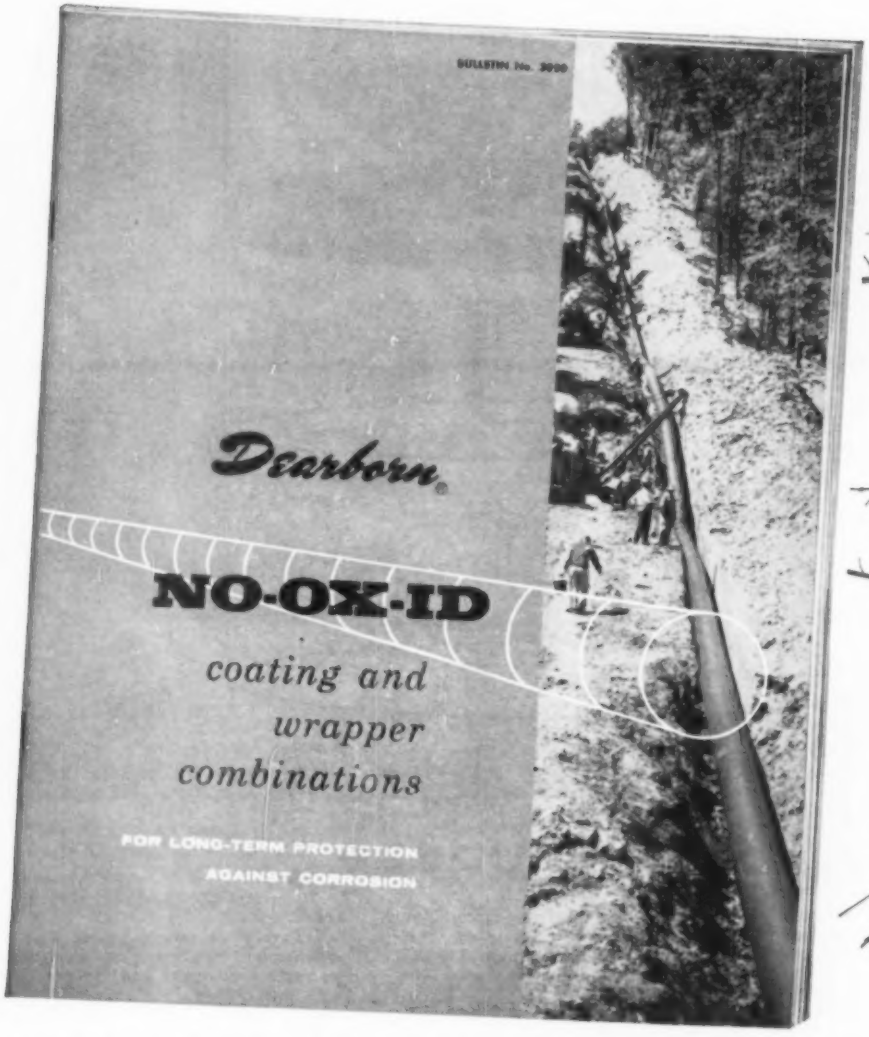
- **Wide, deep carbody with removable bottom cover plates**
- **Crawler rollers and tumblers sealed against dirt**
- **Two-speed travel (optional) through two-speed transmission .8 M.P.H. and 1.6 M.P.H.**
- **Increased stability and flotation with 12'-6" crawlers and 24" or 30" shoes**
- **Long wearing, heat-treated, alloy steel crawler shoes and pins**

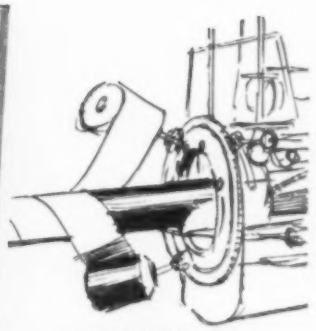
The "Pipeliner" is fully convertible for hoe, shovel, dragline, clamshell and crane work, and is available with gasoline or diesel power. See your Insley distributor for full details or write direct to Insley.

Let Your Insley Distributor Show You an Insley at Work

THERE'S AN INSLEY WORKING NEAR YOU

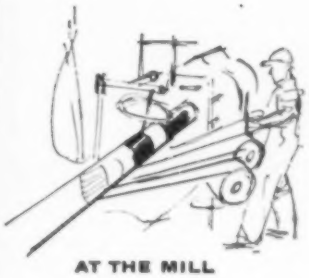
INSLEY MANUFACTURING CORPORATION
INDIANAPOLIS, INDIANA





BY TRAVELINER

BY HAND



AT THE MILL

UP-TO-DATE INFORMATION ON PIPELINE PROTECTION ...NEW NO-OX-ID CATALOG

Dearborn has compiled a new 12-page illustrated catalog describing the latest approved methods of coating and wrapping underground or underwater pipe for long-term protection. Every pipeline contractor, utility and private operator will want a reference copy.

The catalog describes NO-OX-ID compounds and NO-OX-IDized Wrapper combinations developed for corrosion control under all soil conditions. It tells how to apply NO-OX-IDs, hot or cold, by Traveliner, by hand or at the mill... how to get more pipe coverage with less equipment and smaller coating crews.

It pays to specify

Dearborn NO-OX-ID®

Specify NO-OX-ID combinations for long-term protection

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Just fill out the coupon and mail... we will send your catalog promptly. Please indicate the number required for staff use. If you prefer. we will have a Dearborn Pipeline Engineer deliver the catalog when he makes his consultation call.

Dearborn Chemical Company
Merchandise Mart Plaza, Dept. PE, Chicago 54, Ill.

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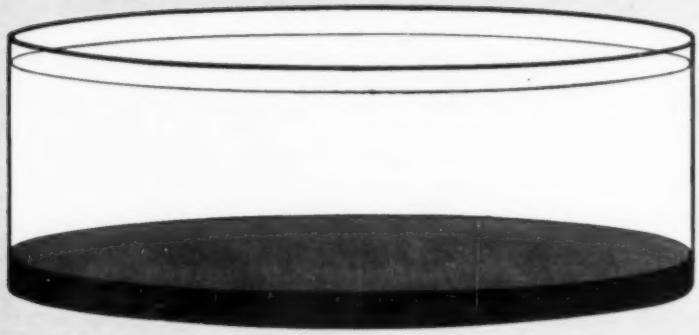
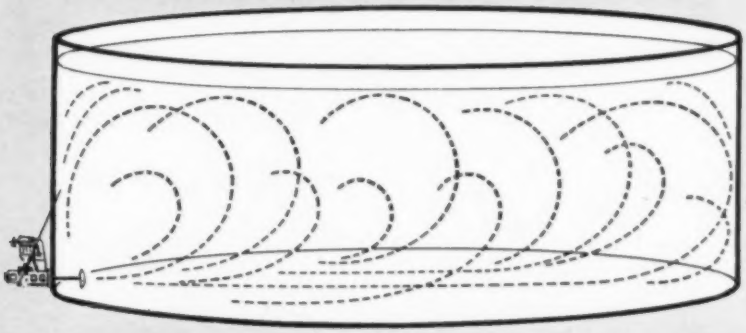


THE EXPENSIVE WAY—If you let sludge pile up in your tank bottoms, you're probably paying much more than you realize for sludge control. Actual tank cleaning cost is only part of the story.



THE LIGHTNIN WAY—You actually save money when you keep tanks free of sludge the easy way, by flipping a switch. Read why LIGHTNIN control of BS&W may save you as much as $1,000 per tank per year.

How do you control SLUDGE?

You can make a one-time investment that will eliminate *for good* the expense and mess of cleaning out sludge in your crude oil tanks.

Just take the money you plan to spend for sludge cleanout in the next year—and invest it in LIGHTNIN Mixers.

How much can this save you on overall operating cost? Careful field tests, by a large pipe line company, show a direct, traceable saving of *$1,000 per tank per year.*

Why you save 3 ways

1. Every time you have to clean out a tank, you spend just about enough to cover the cost of a LIGHTNIN Mixer. With a LIGHTNIN in the tank, you can keep sludge suspended in the crude, or resuspend it if it has settled. You can maintain as little as *one inch* of sludge level in the tank bottom, year after year.

2. You can keep full holding capacity of your tankage ready to use when you need it. No downtime for cleaning out sludge—no sludge pile-up to waste tank capacity. Add as much as *12% more capacity* without adding a single tank.

3. You realize *full value* on the crude you handle. Crude leaving the tank contains the same values as when it entered the tank. With LIGHTNIN Mixers, you can make every barrel in the tank merchantable crude oil.

To get these savings, more than 50 independent pipe line companies and 35 leading producers and refiners use LIGHTNIN Mixers for crude oil sediment control.

What can you save?

Want specifics on what *you'll* save with LIGHTNINS in your tanks? Your LIGHTNIN Mixer representative can give them to you. For quick, competent help, phone him today. (He's listed in your copy of Composite Catalog.) Or write us direct.

Lightnin® Mixers

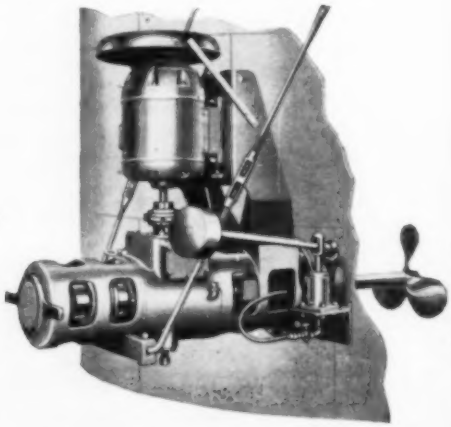
MIXCO fluid mixing specialists

Get these helpful bulletins on BS&W control and LIGHTNIN Mixers. Check, tear out and mail to us today with your name and company address. Free—no obligation.

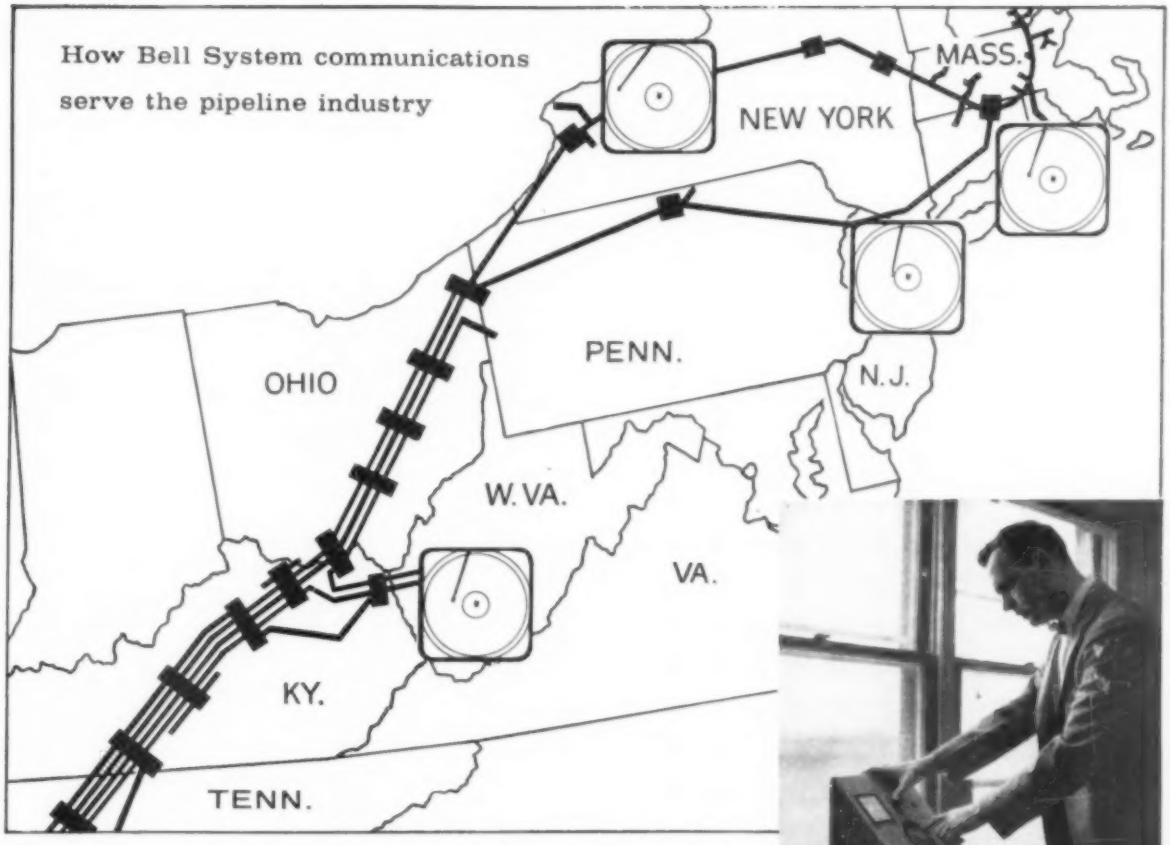
- ☐ B-503 BS&W Control with LIGHTNIN Mixers
- ☐ B-104 Side entering mixers, 1 to 25 HP
- ☐ B-107 Data sheet for figuring mixer requirements
- ☐ B-109 Condensed catalog describing LIGHTNIN Mixers—all types
- ☐ B-111 LIGHTNIN rotary mechanical seals for extra-low-cost mixing

MIXING EQUIPMENT Co., Inc., 127-f Mt. Read Blvd., Rochester 11, N.Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Avenue, Toronto 10, Ont.



YOU CAN GET LIGHTNIN Mixers in sizes from 1 to 25 HP, to control bottom sediment in any tank, new or old, regardless of tank capacity.



Bell System telemetering and remote control enables Tennessee Gas to centralize delivery dispatching in three areas (regional dispatching points indicated on map) in the northeastern U. S. Dispatcher operates remote station valves at market end of pipeline by code dialing.

Tennessee Gas pumps to market with the aid of remote metering and control

Bell System channels for remote metering and control permit Tennessee Gas Transmission Company dispatchers to regulate delivery at 16 unattended measuring points in the northeast.

Almost half of TGT's 1.8 billion cubic foot daily load is metered to four regional dispatching offices near major market areas. Over-all dispatching of the pipeline system is co-ordinated by Bell System private line telephone from Houston, Texas, headquarters.

TGT regional dispatchers open or close valves at delivery points by code dialing. A safety feature in the system enables them to stop delivery in 30 seconds in the event of an emergency.

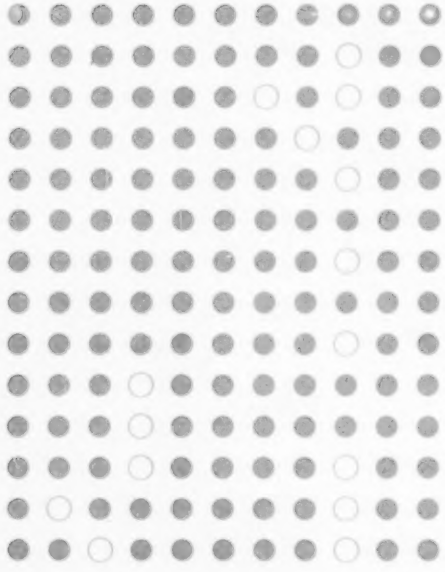
• • •

Efficient communications can save manpower, keep costs down for you, too. Just call your Bell Telephone Company business office. A representative will discuss your needs.

BELL TELEPHONE SYSTEM

PRIVATE LINE TELEPHONE • PRIVATE LINE TELETYPEWRITER • DATA TRANSMISSION SYSTEMS
CHANNELS FOR: REMOTE METERING AND CONTROL · TELEPHOTOGRAPH • CLOSED CIRCUIT TV

K. A. Kissling, *Engineer*
Panhandle Eastern Pipe Line Company



HOW TO PROGRAM TWO-STAGE COMPRESSOR DATA FOR DIGITAL COMPUTERS

THE trend in high speed automatic calculating machines for making engineering calculations is toward the larger more complex machines, with large storage capacity. This is because they are more versatile and efficient for solving complex engineering problems. Many engineering problems, however, may be adapted for calculation on an IBM Model No. 604 Computer or comparable machines, which are used principally by many companies for accounting problems. Purpose of this article is to present one method of using an IBM Model No. 604 for the calculation of performance data for two-stage gas compression, and presentation of this data in the form of curves.

Equations used in this article are the same as those used for single-stage compression. Development of the equations from the basic theoretical equation has been adapted from an article by D. P. Johnson and F. E. Culvern entitled "How to Program Performance Data for Digital Computers"[1] (Single Stage Operation).

The horsepower formula used in this article is a modified form of the theoretical adiabatic horsepower formula.

The theoretical adiabatic horsepower formula is:

$$Hp = 0.08584\left(\frac{n}{n-1}\right)(Q_a)\ (T_s)\ (R^{\left(\frac{n-1}{n}\right)} - 1) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Where:

Q_a = millions of cubic feet per day @ 14.73 psig and 60 F,

Q_s = millions of cubic feet per day @ 14.73 psig and suction temperature,

$Q_s = Q_a$ when $T_s = 520$

T_s = absolute suction temperature of gas °R,

n = ratio of specific heats C_p/C_v.

To convert Equation (1) to the form generally used in gas compressor calculation, divide Equation (1) by $(T_s/520)$.

$$Hp/Q_s = 0.08584\ (520)\left(\frac{n}{n-1}\right)(R^{\left(\frac{n-1}{n}\right)} - 1) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

This is the theoretical horsepower required to compress 1,000,000 cu ft of gas in 24 hours at 14.73 psig and suction temperature.

If the calculated value of $n = 1.277$ the formula becomes:

$$Hp/Q_s = (0.08584)(4.610)(520)(R^{0.217} - 1)$$
$$= 205.77\ (R^{0.217} - 1) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

The empirical formula used in this article is:

$$Hp/Q_s = 215\ (R^{0.217} - 1) + 4R^{0.8} - R^{1.25} \quad . \quad . \quad . \quad (4)$$

Any empirical formula or set of experimental data giving horsepower per million at given compression ratios may be used. To eliminate small errors from the use of a plot of experimental data, it is desirable to derive an empirical formula to fit the experimental data curve.

Capacity of a gas compressor cylinder may be calculated from the theoretical formula for the capacity:

$$Q_s = \left(\frac{(P_1)\ (P_d)\ (E_v)\ 1440}{14.73\ (10)^6}\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

[1]The Petroleum Engineer, June 1956, Page D-25.

Where:

Q_s = millions of cubic feet per day,
P_1 = suction pressure at compressor (psia),
P_d = piston displacement (cfm),
E_v = volumetric efficiency,
1440 = minutes per day,
14.73 = pressure base (psia).

Piston displacement calculation is based on the normal operating speed. Volumetric efficiency may be obtained from a compressor indicator card. Also, it may be calculated from the theoretical or an empirical formula.

Theoretical formula generally used is:

$$E_v = 100 - R - C(R^{\frac{1}{n}} - 1) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

Where:

R = ratio of compression,
C = percent clearance divided by 100.

Empirical formula used in this article is:

$$E_v = 0.98 - C(R^{0.783} - 1) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

Substituting Equation (7) in Equation (5)

$$Q_s = \frac{(P_1)\,(P_d)\,(0.98 - C\,(R^{0.783} - 1)\,1440}{(14.73)\,(10)^6} \quad . \quad . \quad (8)$$

Combining the constants the formula becomes:

$$Q_s = (P_1)(P_d)(0.98 - C(R^{0.783} - 1)(0.00009776) \quad . \quad (9)$$

The equations above are the equations used for single-stage horsepower and capacity calculation. These same equations may be used for two-stage calculations. It is necessary to make separate calculations for each stage and combine the results.

To adapt the equations for the IBM Calculator, multiply Equation (9) by Equation (4) and solve for P_1.

The Author

K. A. Kissling has been employed as an engineer by Panhandle Eastern Pipe Line Company since 1954. Previous to this he spent one year as a process engineer in the Aircraft Division of the Ford Motor Company, and three years as development engineer with U. S. Gypsum Company, working in a paper mill. He received his BS degree in chemical engineering from the University of Missouri in 1949.

$$(Q_s)\frac{Hp}{Q_s} = Hp = (P_1)(P_d)(0.98 - C(R^{0.783} - 1)(0.00009776)$$
$$[215(R^{0.217} - 1) + 4R^{0.8} - R^{1.25}]$$

Solving for P_1:

$$P_1 = \frac{Hp}{(P_d)\,(0.98 - C(R^{0.783} - 1)\,(0.00009776)\,(Hp/Q_s)} \quad . \quad . \quad . \quad . \quad (10)$$

The term P_1 in Equation (10) is the absolute pressure. It is desirable to express the pressure as gage pressure for plotting the final results. By assuming a five pound drop from the main lines to the compressor suction valves and assuming the atmospheric pressure to be 15 psi, the following equation is obtained:

$$P_{1a} = P_{1g} + 10 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

P_{1a} = Suction pressure, psia,
P_{1g} = Suction pressure, psig.

Solve Equation (9) for P_{1a}

$$P_{1a} = \frac{Q_s}{(P_d)(0.98 - C(R^{0.783} - 1)(0.00009776)} \quad . \quad (12)$$

Equation (10) may be used to solve the suction pressure for any assumed value of horsepower at any ratio. Equation (12) may be used in the same manner for any assumed value of quantity being pumped. An examination of these equations indicate two terms that are difficult to solve on a 604 Calculator. Both of these terms: $\frac{Hp}{Q_s}$ and $(R^{0.783} - 1)$ are functions of only the ratio. They may be calculated on the 604 Calcula-

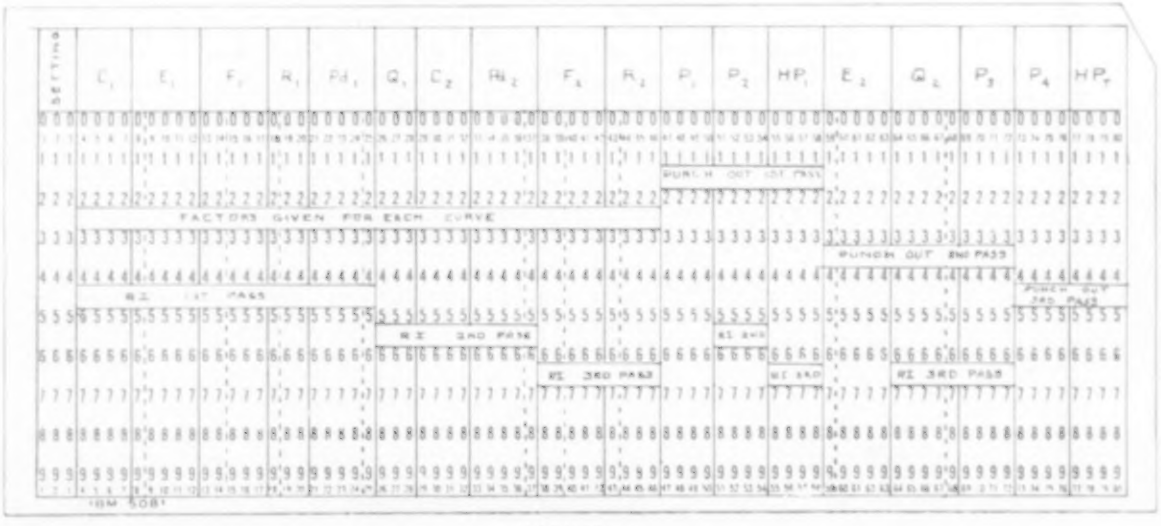
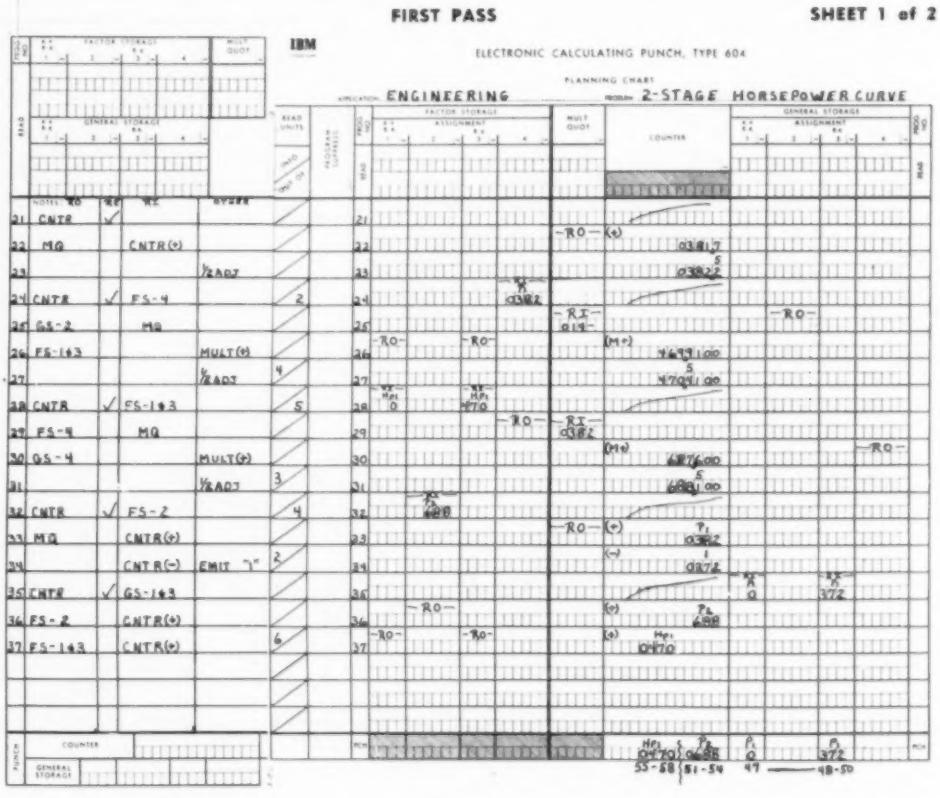


FIGURE 1.

FIGURE 2.


FIRST PASS
SHEET 1 of 2
IBM
ELECTRONIC CALCULATING PUNCH, TYPE 604
PLANNING CHART
ENGINEERING
2-STAGE HORSEPOWER CURVE
FIRST PASS
SHEET 2 of 2
IBM
ELECTRONIC CALCULATING PUNCH, TYPE 604
PLANNING CHART
ENGINEERING
2-STAGE HORSEPOWER CURVE

SECOND PASS **SHEET 1 of 2**

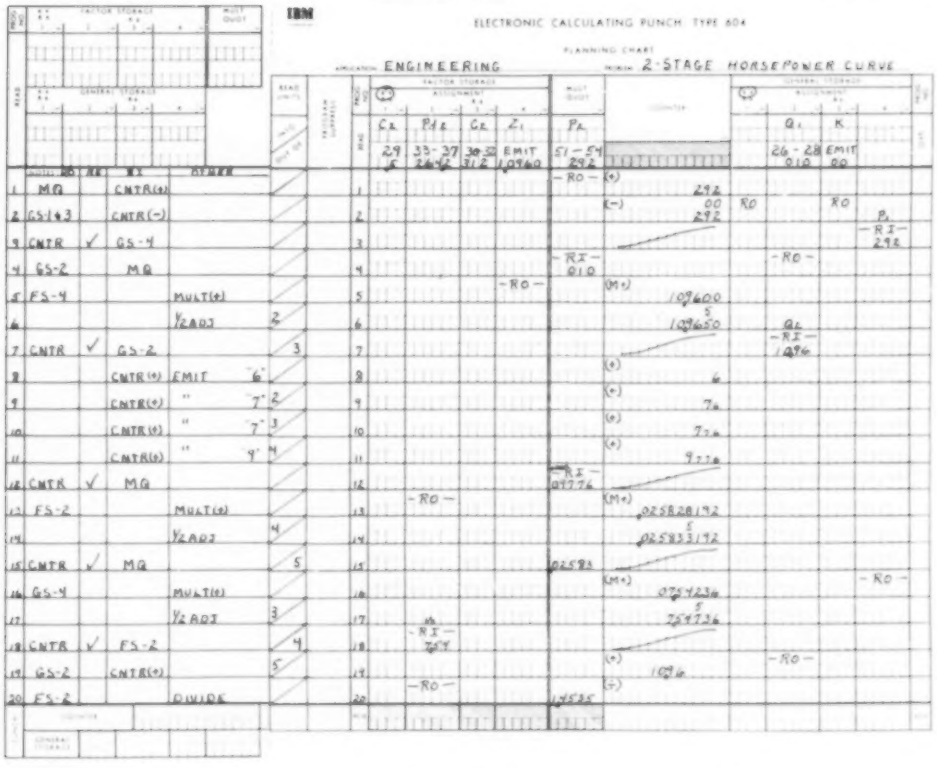


FIGURE 3.

SECOND PASS **SHEET 2 of 2**

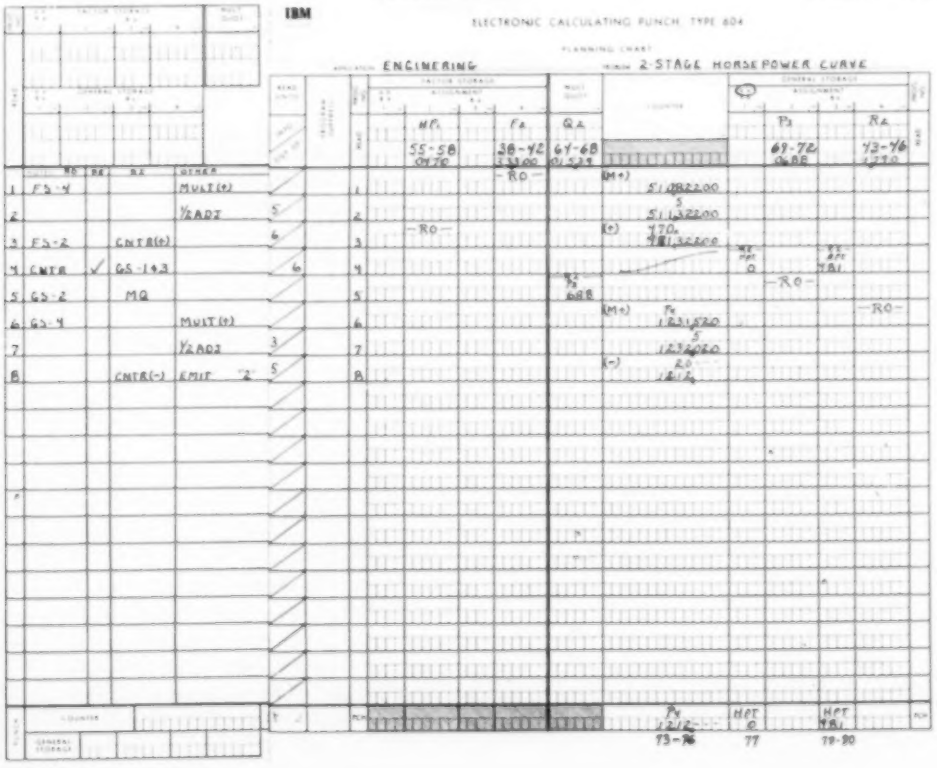


FIGURE 4.

THIRD PASS

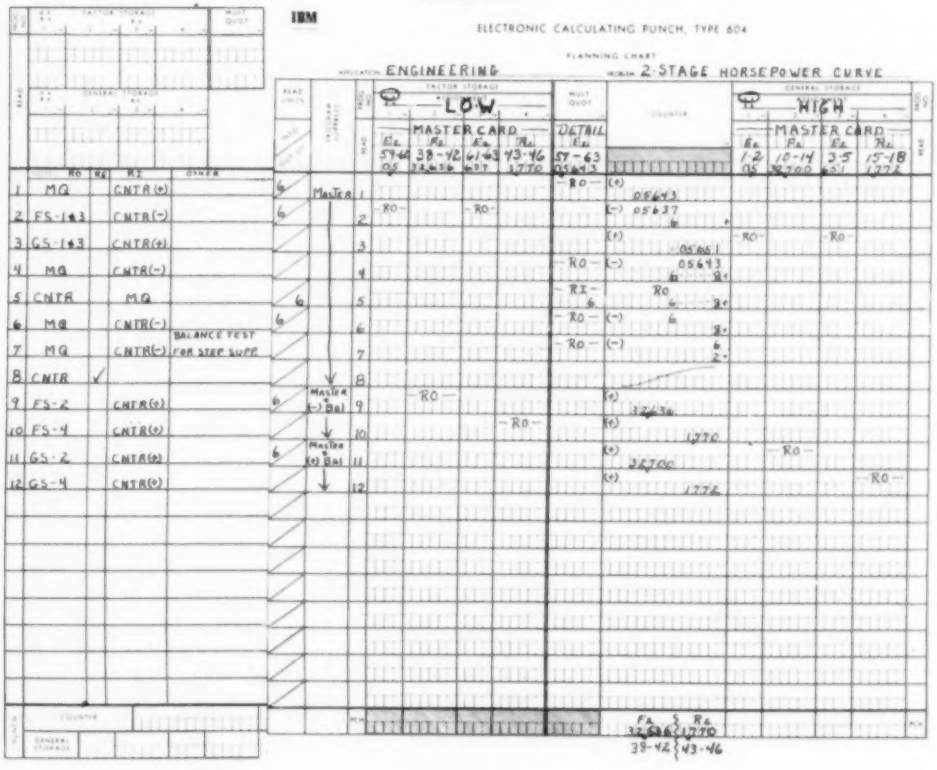
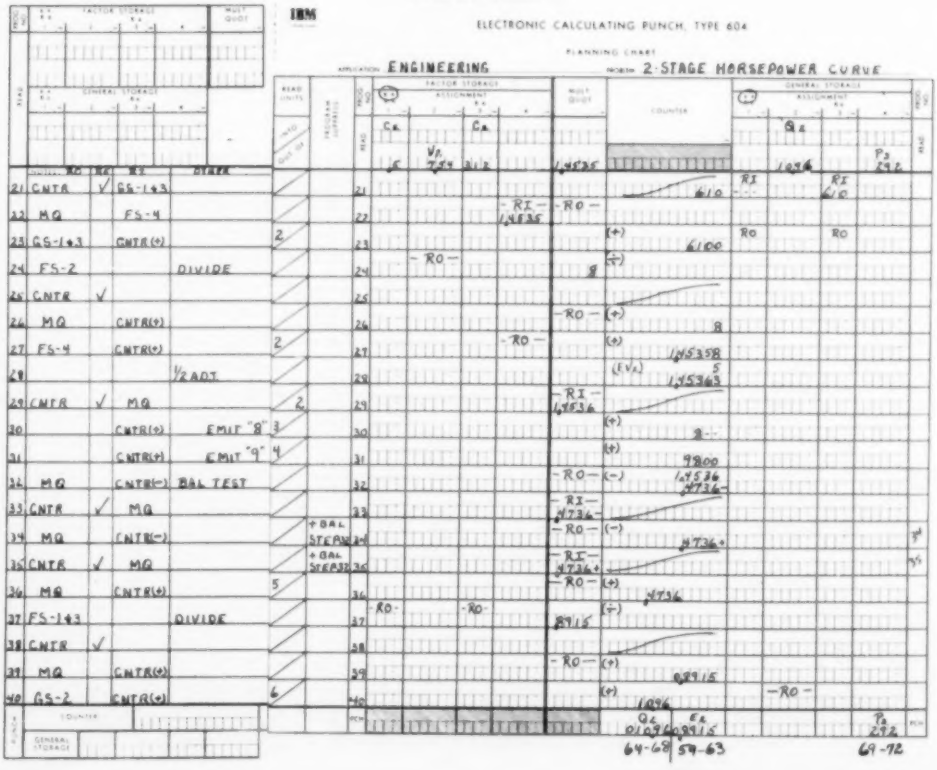


FIGURE 5.

FOURTH PASS



tor by using a logarithmic master deck. This problem may be eliminated by evaluating these terms for all the required specific values of R, and storing these values along with the constants 0.98 and 0.00009776 in a master deck of tabulating cards for permanent reference. (See Table 1.)

The following procedure is used for evaluating Equations (10) and (12) to obtain the necessary data for plotting the two stage horsepower curves:

1. Terms to be handled by the IBM Calculator are given a symbol designation for reference purposes.

TABLE 1. Data Transcribed on the Master Deck.

R	$\frac{Hp}{Q_s}$	$(R^{0.783}-1)$
1.200	12.058	0.1535
1.201	12.082	1542
1.202	12.127	1550
1.203	12.172	1557
1.204	12.216	1565
1.205	12.262	1572
1.206	12.307	1580
1.207	12.351	1587
1.208	12.396	1595
1.209	12.441	1602
1.210	12.463	1610
		Etc.
		Etc.
		Etc.

2. These terms must be described in decimals and significant figures, determined by the degree of accuracy required.

3. Table 2 gives the symbol designations and significant figures we have used in our work.

TABLE 2. Data Transcribed on the Tabulating Cards.

Symbol Designation	Definition	Decimals & Significant Figures
N	Engine setting designation	xx.x
A	Constant	0.00009776
D	Constant	0.98
C_1	Clearance first stage	.xxxx
E_1	$R^{0.783}-1$ first stage	x.xxxx
F_1	Horsepower per million first stage	xx.xxx
R_1	Ratio first stage	x.xxx
P_{d1}	Piston displacement first stage	xxxx.x
Q_1	Capacity first stage	xxx.
C_2	Clearance second stage	.xxxx
P_{d2}	Piston displacement second stage	xxxx.x
F_2	Horsepower per million second stage	xx.xxx
R_2	Ratio second stage	x.xxx
P_1	Suction pressure first stage	xxxx.
P_2	Discharge pressure first stage	xxxx.
HP_1	Horsepower first stage	xxxx.
E_2	$R^{0.783}-1$ second stage	x.xxxx
Q_2	Capacity second stage	xxx.xx
P_3	Suction pressure second stage	xxxx.
P_4	Discharge pressure second stage	xxxx.
Hp_2	Horsepower second stage	xxxx.
Hp_t	Horsepower total	xxxx.
K	Pressure drop between stages	xx.
Z_1	Temperature correction	x.xxx

4. The terms N, C_1, E_1, F_1, R_1, P_{d1}, Q_1, and K are transcribed to a deck of tabulating cards.

5. The procedure for transcribing and calculating the data in the first pass is as follows:

   a. A deck of tabulating cards is key punched with the displacement of the first stage cylinder P_{d1} together with each combination of setting designation N, clearance ratio first stage C_1 and capacity Q_1.

   b. The permanent master deck referred to above containing values A, D, E, and F for all values of R is sorted for the values of R stated in the problem.

   c. All the data on the above cards is then reproduced for each ratio R involved, each combination of N and C_1 involved and each value of Q_1 stated in the problem. This is done by combining the data in (a) and (b) into a deck. This deck becomes the final working deck for the problem. (See Fig. 1.)

   d. The first pass of the working deck is made through the 604 Calculator to develop the values of P_1, P_{2s}, and Hp_1. Fig. 2 shows the calculator planning chart. Operations on calculator planning chart expressed engineering-wise are as follows:

      I. Calculate product of $(C_1)(E_1)$. Store the product and destroy C_1 and E_1.

      II. Subtract $(0.98) - (C_1E_1) = E_{v1}$. Store E_{v1} and destroy previous product.

      III. Multiply $(0.00009776)(P_{d1}) = S_1$. Store S_1 and destroy P_{d1}.

      IV. Multiply $(S_1)(E_{v1}) = T_1$. Store T_1, destroy S_1 and E_{v1}.

      V. $\frac{Q_1}{T_1} = P_{1a}$. Store P_{1a} and Q_1, destroy T_1.

      VI. Multiply $(Q_1)(F_1) = Hp_1$. Store product and destroy F_1.

      VII. Multiply $(P_{1a})(R_1) = P_{2a}$. Store P_{2a} and destroy R_1.

      VIII. Subtract $P_{1a} - 10 = P_{1g}$. Store gage pressure.

      IX. Subtract $(P_{2a}) - (K) = P_{2s}$. Store P_{2s}, destroy P_{2a}, and K.

6. The procedure for transcribing and calculating the second pass is as follows. (See Fig. 3 calculator planning chart.)

   a. Punch out from first pass P_{1g}, P_{2s}, and Hp_1, and read in Q_1, C_2, and P_{d2}. Make the following calculations on the second pass through the 604 Calculator.

      I. Multiply $(Q_1)(Z_1) = Q_c$. Store Q_c and destroy Z_1.

FIG. 6. Two-Stage Horsepower Curve #72.

Setting	Capacity	Hp_t	P_1	P_4	R_1
0.00	10	705	264	871	1.82
0.00	10	723	265	900	1.83
0.00	10	743	266	937	1.84
0.00	10	760	267	965	1.85
0.00	10	780	268	1002	1.86
0.00	10	793	268	1025	1.87
0.00	10	811	269	1062	1.88
0.00	10	826	270	1091	1.89
0.00	10	844	271	1128	1.90
0.00	10	862	272	1166	1.91
0.00	10	870	272	1181	1.92
0.00	10	887	273	1218	1.93
0.00	10	904	274	1256	1.94
0.00	10	920	275	1294	1.95
0.00	10	934	276	1332	1.96
0.00	10	947	277	1362	1.97
0.00	10	957	277	1385	1.98
0.00	10	972	278	1424	1.99
0.00	10	987	279	1462	2.00
0.00	10	1001	280	1500	2.01
0.00	10	1014	281	1539	2.02
0.00	10	1028	282	1578	2.03
0.00	10	1036	282	1599	2.04
0.00	10	1050	283	1639	2.05

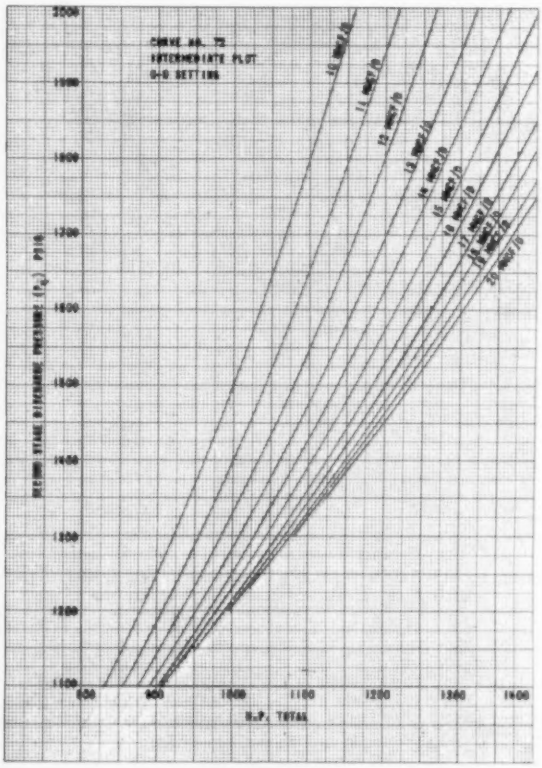


FIGURE 7.

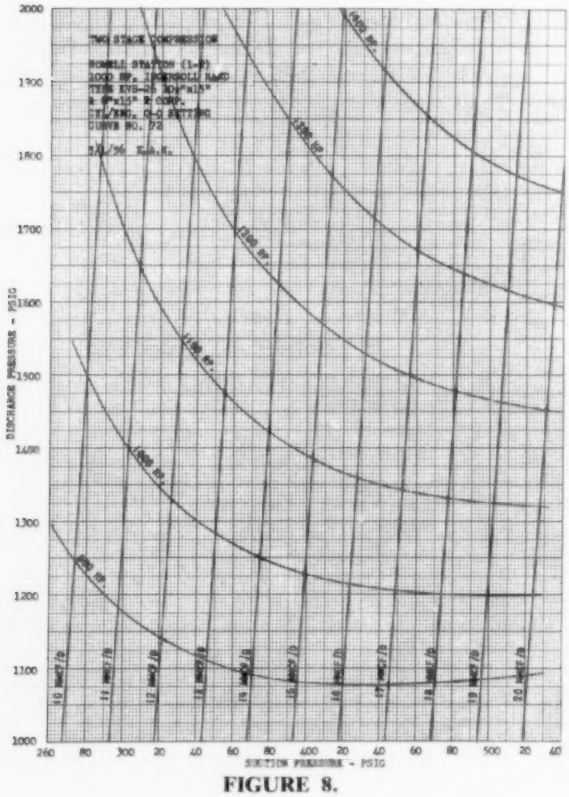


FIGURE 8.

II. Multiply (0.00009776) $(P_{d_2}) = S_2$. Store S_2 and destroy P_{d_2}.

III. Multiply (S_2) $(P_{2a}) = T_2$. Store T_2 and destroy S_2.

IV. $\frac{Q_2}{T_2} = E_{v_2}$. Store quotient E_{v_2} and destroy T_2.

V. Subtract $0.98 - E_{v_2} = T_2$. Store T_2 and destroy E_{v_2}.

VI. $\frac{T_2}{C_2} = E_2$. Store quotient E_2 and destroy T_2.

VII. Punch out E_2, P_{2a}, Q_2, Q_1, Hp_1, and P_1 for the third pass.

7. In the third pass Match E_2 against the master deck and find the corresponding values of R_2 and F_2. (See Fig. 4, calculator planning chart.)
8. Calculate the fourth pass as follows. (See Fig. 5, calculator planning chart.)
   a. Multiply (Q_2) $(F_2) = Hp_2$. Hp_2 Store and destroy F_2.
   b. Add $Hp_1 + Hp_2 = Hp_t$. Store Hp_t.
   c. Multiply (P_{2a}) $(R_2) = P_{4a}$. Store P_{4a}.
   d. Subtract $P_{4a} - 20 = P_{4g}$. Store gage pressure.
9. The tabulated report as shown in Fig. 6 is then prepared on the printer after the data outside the limit ranges has been sorted out.
10. The problem is presented to the tabulating section as follows:

Curve No. 72
Two-Stage Compression.

$T = 72.0,$
$R = 1.20 — 3.00,$
$P_{d_1} = 0472.3,$
$P_{d_2} = 0264.2,$
$K = 00.,$
$Z_1 = 1.096,$
$Q_1 = 010, 011, 012, 013, 014, 015, 016, 017, 018, 019, 020.$

For the above values of Q_1 use the following combination of Settings C_1 and C_2:

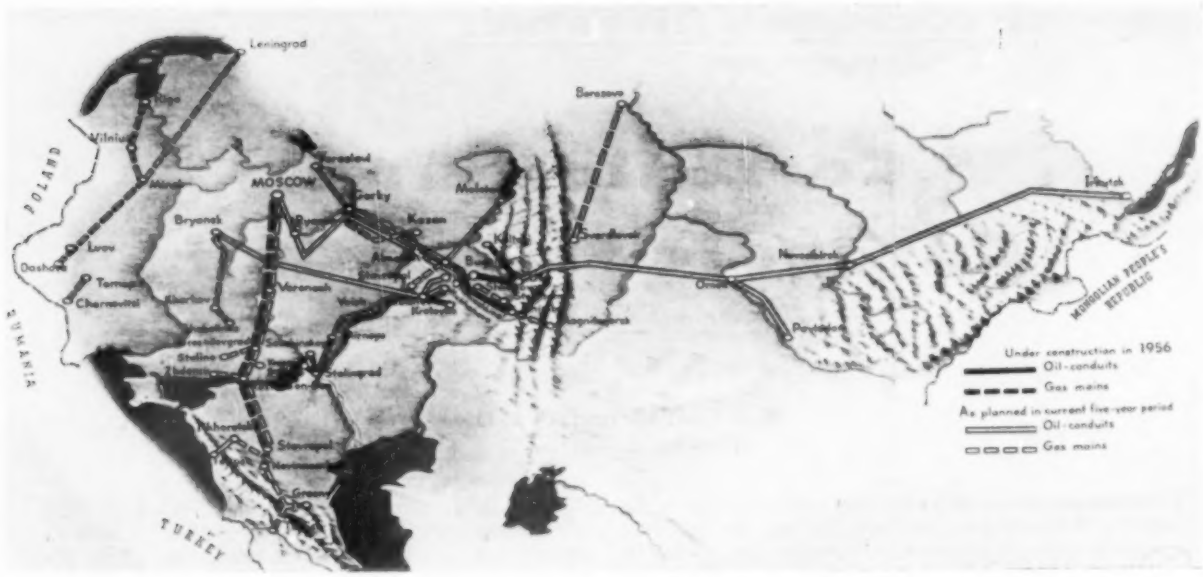
Setting	C_1	C_2
000	0.3194	0.2255
001	.3857	.2255
002	.4520	.2255
003	.5183	.2255
004	.5846	.2255
005	.5846	.5312

Limits to eliminate useless data:

P_2 max $= 1000\#,$
P_4 max $= 2000\#,$
Hp_t max $= 1400,$
Hp_t min $= 700.$

Final charts are prepared from an intermediate plot of horsepower total versus final discharge pressure gage at constant capacity. (See Fig. 7.) On the final chart first plot the capacity line and pick out the values of P_4 from the intermediate plot at the required horsepower and capacity. (See Fig. 8.)

This procedure requires the processings of several thousand cards, however the total tabulating time required for all the engine settings on this problem was only 12 hours. Normal calculation by an engineer to obtain sufficient points for a good curve for all engine settings would take approximately 100 hours. ★ ★ ★



Magnitude of Russia's pipeline building program under the Sixth Five-Year Plan is shown in this map released by N. Yovchenko, USSR deputy minister of oil industry construction. In 1960, Russia hopes to transport about two and one-half times as much oil by pipeline as in 1955.

Russia Meeting Pipeline Goals

Under five-year plan (1956-1960) 9000 miles of crude oil and products lines, and 5600 miles of gas lines, will be laid

Charles L. Adams

RUSSIA is off to a good start on its ambitious program for building oil and gas pipelines under the Sixth Five Year Plan (1956-1960).

Based on construction work accomplished last year, there are indications that the Soviets are meeting and sometimes exceeding their goals. One of the most important Sixth Five-Year Plan natural gas lines — the 808-mile link from Stavropol in the northern Caucasus to Moscow — went into service on December 24, well ahead of schedule.

Other year-end progress reports showed:

About 80 miles of the 700-mile, east-west oil products pipeline between Kuibyshev and Bryansk has been laid. This link starts at Novo-Kuibyshev, site of a new refinery on the Volga River, and terminates in an important industrial area southwest of Moscow.

Most difficult portion of the Kuibyshev-Bryansk line—the mile-long crossing of the Volga—has been completed. Crews are now working west of Syzran.

Another and much shorter line, which also moves "Second Baku" oil, but in the opposite direction, was finished in late December. It extends about 70 miles from the large Tatar Republic oil center of Almetyevsk to Subkhankulovo in the neighboring Bashkir Republic. This line will enable Tatar oil to move on eastward into Siberia via existing systems.

Meanwhile, despite severe winter weather, work is progressing east of Omsk on the vital trans-Siberian oil products pipeline to Novosibirsk and Irkutsk.

Russia claims that benefits from the Stavropol-Moscow gas line will be tremendous even during 1957. The Soviet capital will be getting up to 320,000,000 cu ft of gas daily. All of Moscow's electric stations and hundreds of factories in the capital will be switched over to gas fuel.

By 1960, Moscow will be consuming more than four times as much gas as in 1950 and millions of tons less coal. Stavropol gas also serves such major Russian industrial centers as Rostov-on-Don, Zhdanov, Taganrog, Voroshilovgrad, and Voronezh.

The 28-in. Stavropol-Moscow line, with compressor stations every 60 miles, gives Moscow three major sources of natural gas. A 12-in. line, built during World War II, originates at Saratov on the Volga River. A 20-in. line, completed six years ago, extends from Dashava in the far-western Ukrainian gas fields near the Carpathian Mountains to Moscow via Kiev.

Speed of laying the Stavropol-Moscow line far exceeded the pace set on previous Soviet gas pipeline projects, according to Russian reports. More than 1000 heavy trucks, 450 tractor pipelayers, 340 automatic welding machines, and hundreds of excavators, cranes, and bulldozers participated in the work. The welds were checked by radioactive cobalt devices.

Overall, the USSR's Sixth Five-Year Plan contemplates completion of close to 15,000 miles of pipelines — about 9000 miles for crude oil and products and 5600 miles for natural gas (*The Petroleum Engineer*, April, 1956). By 1960, the amount of oil delivered by pipelines in the Soviet Union will be 2.5 times the 1955 volume if construction goals are met. ★ ★ ★

SELECTED CORROSION LITERATURE

... A Continuing Series

Corrosion And Cathodic Protection

H. V. Beezley and G. R. Olson

United Gas Pipe Line Company, Shreveport, Louisiana

Editor's Note: This is the second and concluding part of the article by Messrs. Beezley and Olson. The first part, published in May, discussed the principles of corrosion. An explanation was given of the various types and causes of corrosion. The authors, in concluding, give in detail the accepted methods for controlling corrosion on pipeline systems.

Fig. 10 illustrates the galvanic cell formed when new pipe is welded into old pipe, as previously mentioned.

Fig. 11 shows a brass valve in a steel line. Although a fairly high corrosion potential may exist in this case, the rate of corrosion may not be excessive because area of the brass valve is usually small as compared with the pipe. However, this may not always be the case and such construction should be avoided if possible. Where brass valves must be installed in steel lines they should be coated with a good quality pipe coating recommended for underground use.

Fig. 12 shows a corrosive condition that exists when a pipeline passes from fairly dry well-aerated soil through a marsh where the soil is usually very wet and of low resistance. In such cases, electricity usually leaves the surface of the pipe in the marsh and travels through the earth to collect in drier comparatively well-aerated sections. These are sometimes called long line currents and they cause accelerated corrosion in the swamps.

Fig. 13 illustrates a corrosive condition that exists when the pipeline passes through two entirely different types of soils. This would usually be another case of long line currents.

Fig. 14 shows the corrosion cell formed by the higher moisture existing at the bottom of the pipeline ditch. The flow of electricity in this case is from the bottom half of the pipe, through the soil, and back onto the top of the pipe. Experience has shown that most leaks occur on the lower half of a pipeline.

Fig. 15 shows the effect of mixing soil when backfilling a pipeline. Flow of electricity in such cases usually covers a very short distance, therefore, corrosion cells are referred to as local cells.

Fig. 16 shows the corrosive action of electrolysis upon a pipeline in the vicinity of a street railway. Note the generating plant with an overhead trolley carrying electricity to the trolley car from which it returns to the generating plant through street rails. These steel rails are usually poorly insulated from the ground, consequently, a portion of the return current frequently flows back to the generating station through the ground. This stray return current may collect on nearby gas and water pipes and follow them to some point near the generating station where they leave the surface of the pipe to return to the generator.

Corrosion caused by electrolysis near the railway substation can usually be controlled by draining the current through a metallic conductor to the negative bus at the generating station.

It should be pointed out that a large number of the many forms of corrosion cells illustrated and described here usually will be acting simultaneously on any section of pipe where severe corrosion action is present.

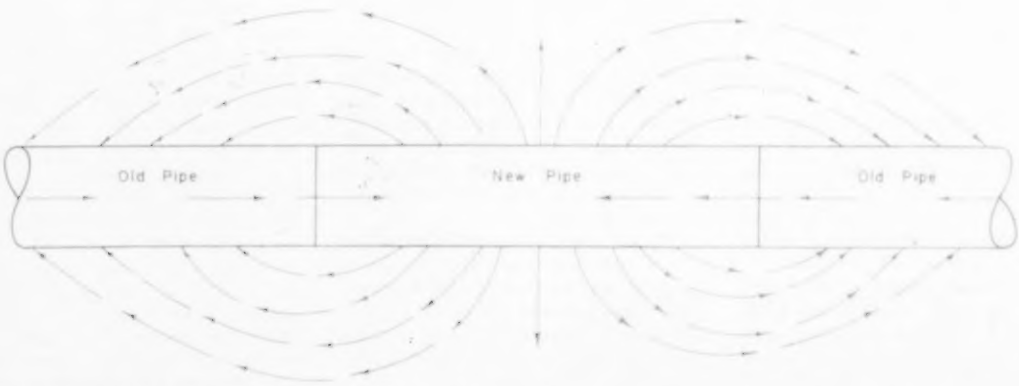


FIG. 10. Corrosion due to dissimilar metal (new pipe welded into old pipe).

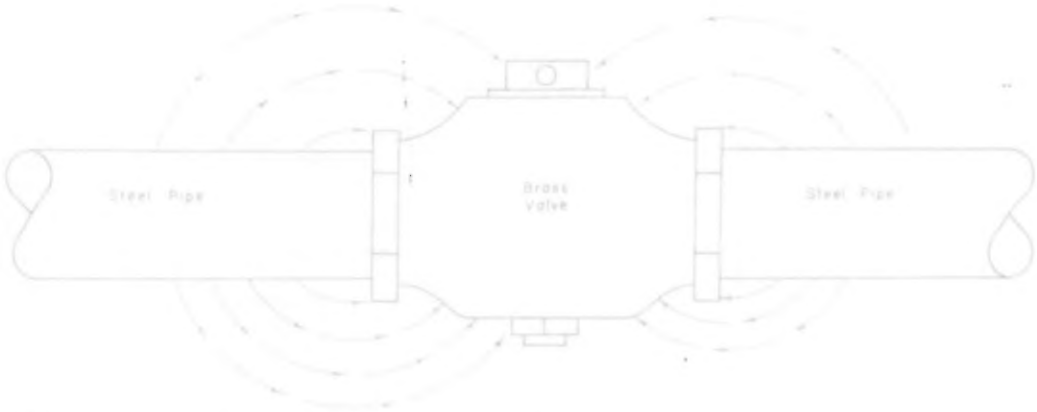


FIG. 11. Corrosion caused by dissimilar metals (brass valve in a steel line).

Methods of Corrosion Control on Pipelines

In general, the most common means of corrosion control are coatings which have the greatest electrical insulation values, extra pipe wall thickness, cathodic protection, and a combination of any two or all of these methods.

Twenty to 30 years ago, the most effective means of corrosion protection known was extra pipe wall thickness. Although some pipeline coatings were then available, they had not been developed to give the effective protection available in present day coatings. The principle of cathodic protection has been known for more than 125 years, but it is only in recent years that this principle has been applied on a large scale to the protection of pipelines and other underground structures.

The use of extra pipe wall thickness is rapidly decreasing as other means of corrosion control are now generally more economical. This is easily understood if we consider that the cost of pipe delivered to the job is an approximate function of its weight. To take a specific example, 16-in. pipe with a ¼-in. wall thickness weighs about 42 lb per ft. If we add 1/16 in. to the wall thickness, the weight becomes a little more than 52 lb per ft. At present day steel prices, this increase in weight adds about $4400 per mile to the cost of 16-in. pipe. In addition, there are increased construction costs because of the added weight.

Wall thickness of a proposed pipeline is now usually determined by the pressure the line is designed to carry and very little, if any, wall thickness is added to compensate for corrosive action of the soil.

There are a number of pipeline coatings available today that have been manufactured in accordance with high standards. These coatings are more than paints; rather, they are excellent shields that insulate the pipe from the soil. It is difficult, however, to lay a pipeline in such a way that no holidays will exist in the coating after the line is backfilled. An initially holiday free coating can be obtained by using certain types of detectors to go over the backfilled line, locating all holidays, then digging the line up to patch the coating. After this has been done, perhaps several times, it is possible that the line could be checked and found to be perfectly free of holidays.

Such rigid requirements for coatings are very expensive, however, and add considerably to the cost of the line. In addition, and this is probably the most important point, seasonal changes in the condition of the soil will cause high stresses to be exerted upon the coating, which, in time, will distort it and weaken it materially. Therefore, a coating (without reinforcing or shielding) with absolutely no holidays immediately after construction may in time contain a large number of holidays. If the pipe passes through corrosive soil, leaks probably will occur in these holidays within a short time because the

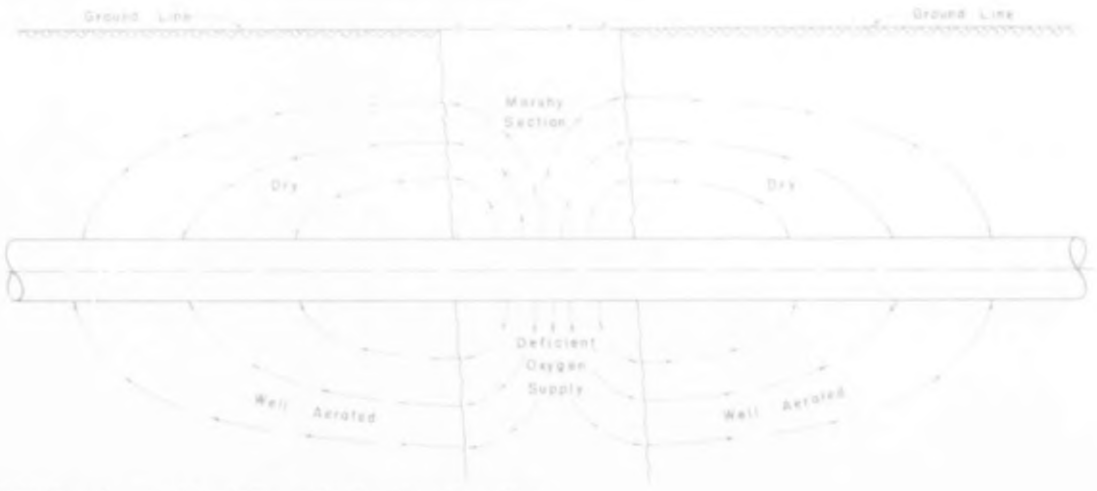


FIG. 12. Corrosion caused by pipeline passing through marshy section.

corrosive action will be concentrated in small areas.

A more satisfactory and economical method of corrosion protection is to apply properly a good coating with suitable reinforcing wrappers and apply cathodic protection to prevent corrosive action at any holidays that may occur.

If a good quality coating is properly applied and carefully handled during installation and backfill, the number of holidays existing on the completed line will be small. On such lines, the total current requirements for cathodic protection will be almost negligible.

Since cathodic protection costs are usually proportional to current requirements, the cost of applying cathodic protection to a well coated line will be small, frequently less than 2 percent of the cost of the coating. Application of cathodic protection to these lines gives the equivalent of a practically perfect coating provided the cathodic protection is properly installed and maintained in such a way that it operates continuously.

On bare lines that were laid years ago when construction practices as we know them today had not been developed, corrosion control presents an entirely different problem. The following methods may be considered.

1. **Keep leaks repaired until pipe becomes unsafe to operate, then replace.**
2. **Immediate replacement.**
3. **Reconditioning.**
4. **Cathodic protection.**

The first and last of these methods are the most generally used. Replacement is expensive and is normally delayed as long as possible, provided the pipe is safe to operate. Reconditioning is usually just as expensive as replacement.

In some cases, the most economical means of corrosion control is simply to keep leaks repaired until the pipe becomes unsafe to operate, then replace the unsafe sections. This was particularly true a number of years ago when the costs of product lost, leak repairs, and replacement were relatively low. In recent years, however, the rapid increase in construction cost, as well as operating costs, has made this means of corrosion control unprofitable in most cases. If this method of corrosion control is used, it should be remembered that once replacement is made, the problem of protecting the replaced sections becomes that of protecting new pipe and the selection of a method of corrosion control should be made on this basis.

Cathodic Protection

In the discussion of corrosion cells, it has been stated that corrosion occurs where an electric current leaves a metal to flow into a surrounding electrolyte. Cathodic protection reverses this process by forcibly causing a current to flow from the electrolyte into the metal. If enough protecting current is applied to oppose and stop all discharge of current from the metal, protection will be complete and no further corrosion will occur.

In the case of a steel pipeline buried in the soil, protection is applied as shown by the simple cathodic protection circuit in Fig. 17.

A suitable ground bed, consisting of junk pipe or carbon rods, is buried in the soil as shown at "A." A generator, or some other source, "G," supplies direct current with the positive terminal connected to the ground bed and the negative to the pipe through suitable cables. The protecting current is thus forced out through the soil and flows on to the surface of the pipe as indicated by the long arrows. Short arrows on the pipe surface indicate the tendency of corroding current to leave the pipe surface and enter the soil.

In the case of a Dresser coupled line, the couplings must be bonded, as shown in Fig. 18, in order to make the line electrically continuous. On such lines, periodic tests must be made to locate any bonds that have been broken loose by expansion or faulty welds. When this occurs, electrolysis will accelerate corrosion near the couplings, as indicated in Fig. 18. Repairs of such open bonds should be made as soon as possible.

Criterion of protection is generally accepted to be a pipe-to-soil potential of 0.80 v as measured with a copper sulfate plug. This means that there is an actual difference in potential between pipe and soil of about 0.30 v with the pipe negative to the soil. On coated lines, the pipe usually can be lowered in potential to the desired 0.30 v with the application of a relatively small amount of current because the *coating insulates the pipe from the soil.*

Usually, this can also be accomplished on bare lines in tight soils or soils that are permanently moist, although the current required will be considerably larger. This is because the pipe becomes polarized in those soils that tend to exclude oxygen from the pipe surface. This polarization effect is the for-

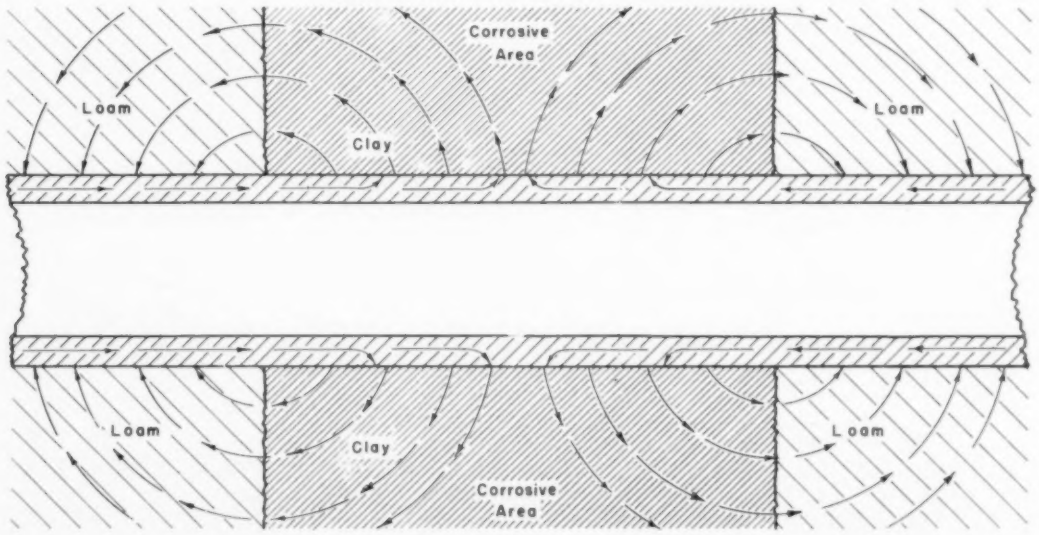


FIG. 13. Corrosion caused by dissimilar soils.

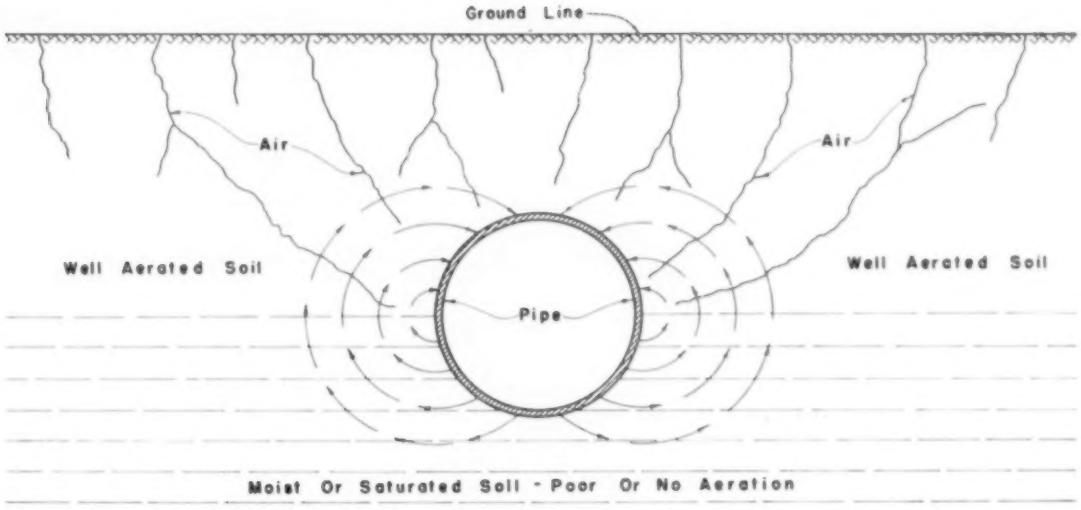


FIG. 14. Corrosion caused by differences in air and moisture content of soils.

mation of a hydrogen film on the pipe, which partially insulates the pipe surface from the soil. It is due to electrolytic action, which disassociates moisture in the soil into hydrogen and oxygen, the hydrogen being carried to the surface, which is cathodic.

But in dry, well-aerated soils, a bare pipe surface will not become polarized, and since soil and pipe remain in intimate contact, a great enough difference in potential cannot be obtained by practical means. In such cases, criterion of protection is generally accepted to be a current density of 3 milliamperes per sq ft of pipe surface. It will be found that this current density will not provide complete protection in some soils, but where such severe corrosive conditions exist, cost of complete protection may be prohibitive; consequently, partial protection, which serves only to retard corrosion, is usually accepted as giving the most economical results.

Although other methods are sometimes used, the foregoing criterions of protection are those in most common use. However, most cororsion engineers will agree that no infallible instrumental method of determining exactly when a pipe is under full protection has yet been devised. In the final analysis, criterion of protection is the absence of leaks on the section of line under consideration.

After the minimum current density required is decided upon, it will be found that a considerable excess of current must be supplied in order to obtain this minimum density at all points on the pipe surface.

This is illustrated by Fig. 19, which shows a theoretical curve of current density plotted against distance from the source of current. In this case, it was desired to obtain a minimum current density of 3 milliamperes per sq ft. All of the shaded area above the 3 milliampere line represents wasted energy. If the cost of electric energy is high, this wasted energy becomes of considerable importance.

A more efficient means of obtaining the desired protection is to use a large number of smaller sources of electric current. This is illustrated by Fig. 20 in which the smaller cross-hatched areas represents the energy loss where the one large source is replaced with 11 smaller ones. Total current from the 11 sources would, of course, be much less than current from the one large source.

It must be pointed out and emphasized that these theoretical curves will never be obtained in practice because the condition of the pipe surface and its environment will vary widely over the section being protected. They are brought in here to illustrate a principle that must be taken into account in the efficient design of cathodic protection. Location and spacing of these current sources are normally based upon a number of factors over which the engineer has no control, as well as his past experience combined with the necessary field tests.

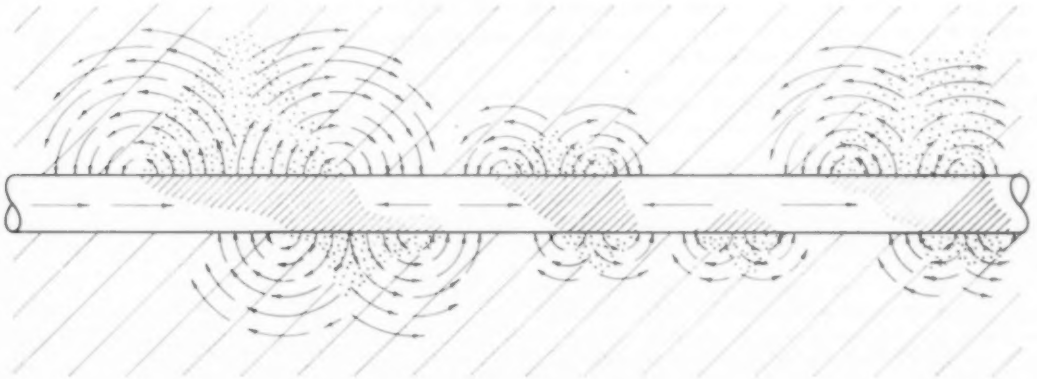


FIG. 15. Corrosion due to different types of soil that have been mixed as a result of excavating and backfilling, grading, or reclaiming wasteland.

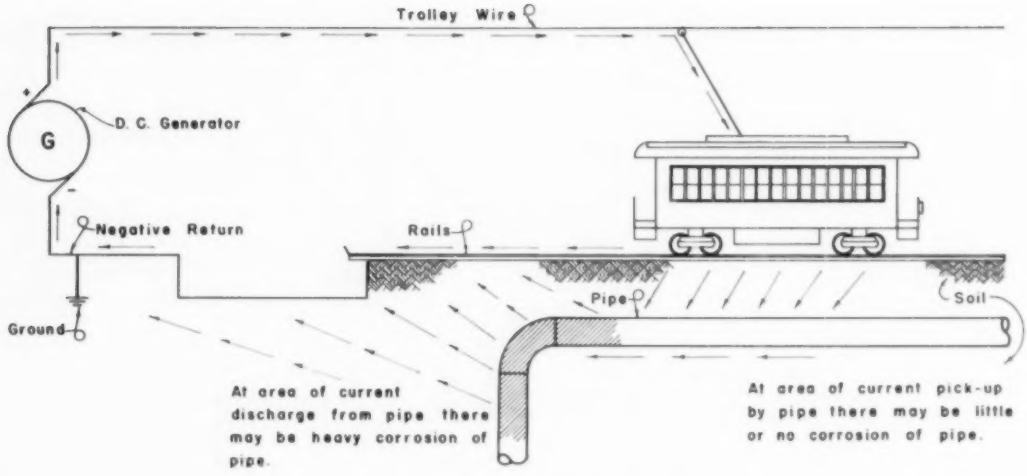


FIG. 16. Corrosion on a pipeline, or other buried metal structure, caused by discharge of stray currents picked up from an electric railway system.

As current sources, the following equipment is most commonly used:

1. **Rectifiers,**
2. **Galvanic anodes,**
3. **Gas engine generators,**
4. **Wind-driven generators.**

Selection of this equipment is dependent upon economic factors, availability of electric energy, availability of right-of-way, soil conditions, and location of qualified maintenance personnel.

This last named is of paramount importance. In order for cathodic protection to be successful, flow of current on the surface being protected must be continuous, or as nearly so as possible. It has been found that satisfactory results will not be obtained if the protecting current is not applied at least 90 percent of the total time, and the more nearly this figure approaches 100 percent, the more satisfactory will be the results. Without adequate maintenance of equipment and periodic tests to determine the need for adjustments and repairs, no corrosion control program will be successful.

Rectifiers and galvanic anodes are most commonly used because they provide the most dependable source of current with the least maintenance.

Rectifiers, which convert purchased alternating current energy into direct current, are probably most commonly used where relatively large amounts of current are required. Dependability of purchased power is well established, and a rectifier installation may be expected to remain in operation almost continuously. If responsible diligence is exercised by personnel in charge of maintenance, operating time of a rectifier will seldom fall below 95 percent.

For protecting large diameter bare lines, a system has been developed consisting of a 2-conductor power line, built along the pipeline right-of-way, with 5 to 10 small rectifier units per mile installed to provide a well distributed protecting current.

This type of construction is illustrated by Fig. 21. Rectifier design is such that extreme flexibility is provided in that the capacity of any unit can be easily changed by adding, removing, or changing rectifier stacks. Our company has used this type of installation for 15 years and found it to be very satisfactory. It will usually supply current at the lowest cost per ampere year.

Where a very short section of pipe is to be protected, or on lines having a coating in even fair condition, single rectifier units may be used provided purchased power is available at suitable locations. With an installation of this type, excessive current must be supplied near the unit in order to obtain a satisfactory spread of protection, and the installation as a whole is not as efficient as a group of multiple rectifier units. However, this is frequently the most economical type of installation and its use is quite common.

Where relatively small amounts of current are required, galvanic anodes provide a dependable and economical source of current.

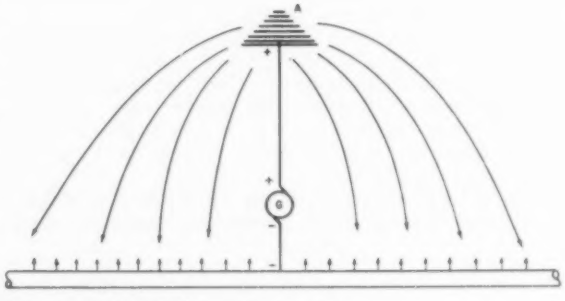


FIG. 17. Simple cathodic protection circuit.

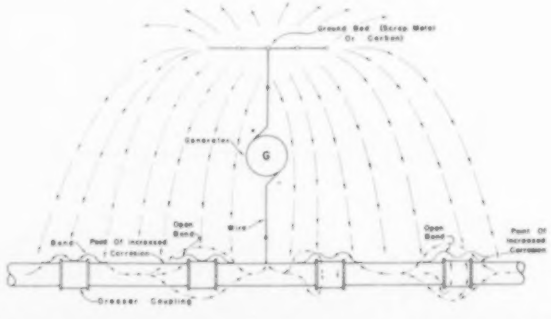


FIG. 18. Acceleration of corrosion by unbonded or poorly bonded Dresser couplings.

Referring to the galvanic series previously discussed, it will be noted that there are several metals above steel. As previously discussed, if any two of the metals are connected together metallically and buried underground, the metal higher in the series will corrode and discharge an electric current that will protect the metal lower in the series.

This principle is used in the protection of pipe in that a metal above steel in the series is selected and buried near the line with a connecting copper wire to the pipe. A metal that is thus used is called a "galvanic anode." The most commonly used metals for this purpose are magnesium and zinc. Although the cost per ampere year for protection in this manner will be greater than rectifiers in most cases, local conditions will frequently favor this type of installation.

In comparing magnesium and zinc, experience has shown that there is a place for each in the application of cathodic protection. In all soils except those of very low resistivity, magnesium usually will be favored over zinc because of its greater driving potential. Zinc has the higher anode efficiency, but its use on a long pipeline is somewhat limited by its relatively low driving potential. In soils of low resistivity, however, the potential of zinc is sufficient to give a satisfactory current output and its use would be favored in such cases. Because of right-of-way requirements, soil conditions, or other local factors, galvanic anodes are usually installed in banks of 5, 10, or more.

At locations where large amounts of current are required and purchased power is not available, gas engine driven generators must be used. This source of current is not as dependable as purchased power. In order to obtain satisfactory service from gas engine generators, a well organized maintenance program must be set up specifically for this purpose, and close check on the operation of the units must be kept to see that continuity of operation is maintained. If this is done, the results obtained will be quite satisfactory.

Wind-driven generators will not supply the necessary large amounts of current continuously to provide protection to a large diameter bare pipeline. These units have been used with some success, however, to provide protection to short sections of line in locations where the wind blows very nearly continuously.

Recently galvanic anodes have been used in conjunction with wind-driven generators. Along the same section of line being protected by the windmills, a relatively small number of galvanic anodes are installed to provide a continuous flow of current during periods of calm when the wind generators do not operate. Because of changes in pipe potential, galvanic anodes automatically will increase their output as the windmill slows down or stops.

To illustrate factors that must be taken into account in designing cathodic protection, it might be well to consider two hypothetical cases.

In the first, assume that a section of 12-in. line, 20 miles long, is being protected. Current requirements have been determined to be about 1 amp per mile of pipe although well coated lines usually require much less if casings are well insulated.

This current requirement would be estimated on the basis of past experience with previous lines protected under the same conditions, or it might be determined from actual tests by applying a temporary source of current such as from a welding machine. At 1 amp per mile, a total of 20 amp would be required. Choice in this case probably would be between galvanic anodes or a large rectifier unit.

If soil resistivities are suitable, 20 amp can be obtained from about 200 magnesium anodes. If possible, it would be desirable to install these in banks of 5 or 10 with 1 or 2 banks per mile. This would mean that soil resistivity measurements must be made about every half mile.

In all probability, suitable low resistance soil would not be found at every location first tested, consequently it would be necessary to make additional tests to obtain the most satisfactory locations for the anodes. This would mean that the final design would show anode banks at varying distances apart over the entire line. Galvanic anodes could not be used on this

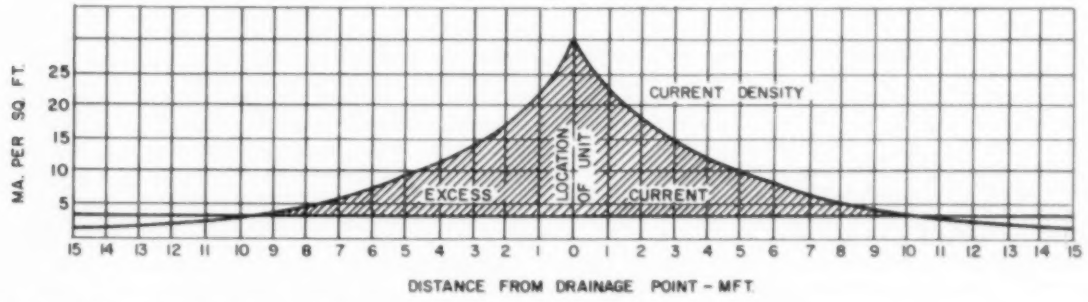

MA. PER SQ. FT.
25
20
15
10
5
CURRENT DENSITY
LOCATION OF UNIT
EXCESS
CURRENT
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
DISTANCE FROM DRAINAGE POINT - MFT

FIG. 19. Use of only one large source of electric current results in energy loss.

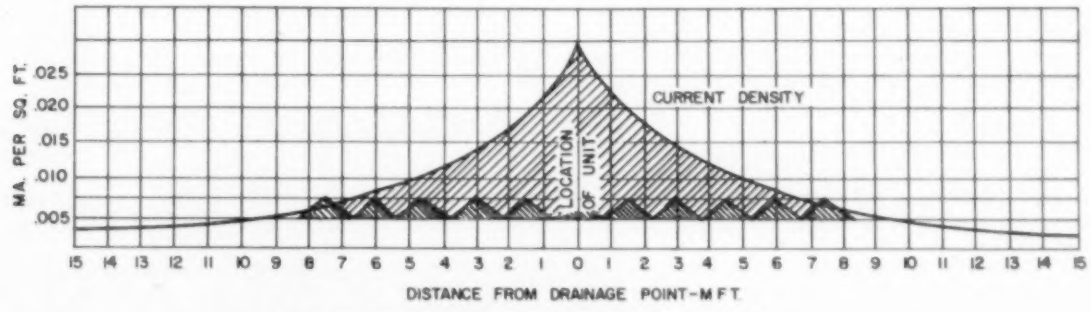

MA. PER SQ. FT.
.025
.020
.015
.010
.005
CURRENT DENSITY
LOCATION OF UNIT
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
DISTANCE FROM DRAINAGE POINT-MFT

FIG. 20. Use of many small sources of electric current instead of one large source is a more efficient means of obtaining desired protection.

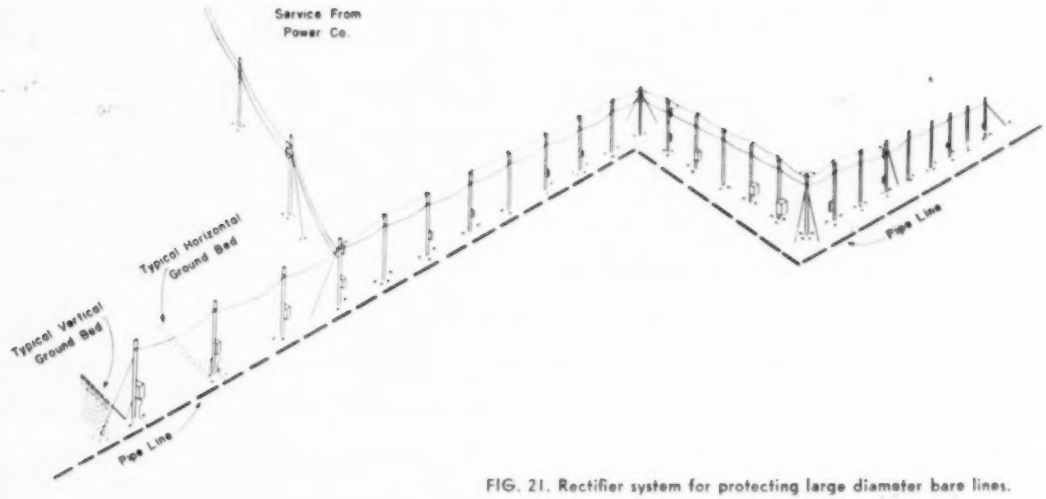


FIG. 21. Rectifier system for protecting large diameter bare lines.

line unless a sufficient number of locations were found where reasonably low resistance soil existed.

Probably more economical protection could be obtained from a single large rectifier unit provided electric power is available near the center of the line. In this case, the first step would be to locate all available places for obtaining electric power. Soil resistivity measurements would then be made at these locations and a site selected somewhere near the middle of the line where the lowest soil resistance was obtained and where the unit would be accessible for regular maintenance.

The unit would be designed for this location and an efffort made to obtain the necessary right-of-way. If right-of-way could not be obtained, or if its cost were excessive, it would be necessary to select another location for a new design. If a single unit could not be installed near the center of this section, 2 smaller units nearer the opposite ends would be satisfactory and economical.

In either case, the total capacity provided with rectifier units should be about 30 amp. This additional capacity would be required because the current would be needed near the unit to protect the extremities of the line. This would also provide some flexibility in adjusting current outputs to suit requirements indicated by field tests.

If this 20-mile section of 12-in. line were bare, a different problem would be presented. Experience has shown that about 50 amp per mile are required to protect a bare 12-in. line in most corrosive solls. This would mean a total of 1000 amp, provided the current could be evenly distributed.

The most satisfactory and economical protection in this case would be from an installation consisting of 5 to 10 small rectifier units per mile with a distribution line built down the pipeline right-of-way to serve the units. To design this protection, a pole line would be laid out over the entire section with soil resistivity measurements at every pole. Small units would then be located and designed from the field data with spacing depending upon the engineer's judgment of the length of line that will be protected from each.

Lower electric energy costs would usually be obtained if the entire section could be served through one meter; however, right-of-way difficulties will frequently make it necessary to break the distribution line into several sections with a separate meter for each.

Use of cathodic protection has increased enormously during the past 10 to 15 years. This is due to the fact that its effectiveness has been well demonstrated over long periods by many applications to pipeline systems.

Savings to be effected by its application are as follows:

1. Cost of leak repairs.
2. Cost of reconditioning and replacement.
3. Products lost through leakage.
4. Damages.
5. Loss of goodwill.
6. Loss of revenue.

Probably the greatest advantages of cathodic protection are the savings in products lost and increased life of the pipe. These two items are difficult to evaluate accurately; however, they undoubtedly exceed any other corrosion costs on older lines.

Losses due to crop damage from leakage and work done by repair crews with the loss of property owner goodwill are obvious. In addition, where lines are loaded to capacity, any product loss through leakage reduces the capacity of the line and represents a definite loss of revenue.

Summarizing, we have seen that corrosion is due to the discharge of an electric current from the surface of a metal into an electrolyte. This flow of electricity may be caused by galvanic cells, concentration cells, electrolysis, or a combination of these factors.

Corrosion may be controlled by coatings, extra metal thickness, cathodic protection, or a combination of these methods.

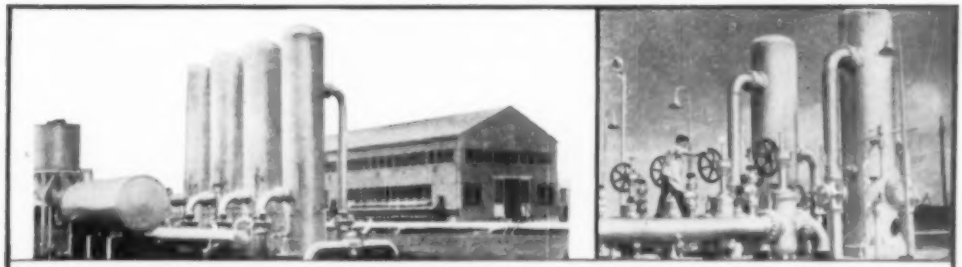
Cathodic protection, which is the forced flow of an electric current in a direction that opposes the flow of the corroding current, is an effective and economical means of corrosion control.

The most commonly used sources of electricity for cathodic protection are rectifiers, which convert purchased alternating current energy to direct current, and galvanic anodes, which utilize the discharge of current from a metal higher in the galvanic series than the metal being protected.

Gas engine generators and wind-driven generators are also used where large amounts of current are required and purchased electric energy is not available.

This greatest savings effected by the use of cathodic protection are in increased life of the pipe and in cost of products lost. Additional savings are in leak repairs, damages, goodwill, and loss of revenue.

Use of cathodic protection has become quite common over the past 10 to 15 years because its effectiveness has been well demonstrated over long periods by many practical applications. ★ ★ ★



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Further particulars on the use of dependable RCA Microwave in utilities, pipelines, offshore drilling, turnpike and other applications will be mailed on request. RCA Microwave specialists are experience-qualified to answer your questions and help plan your installation

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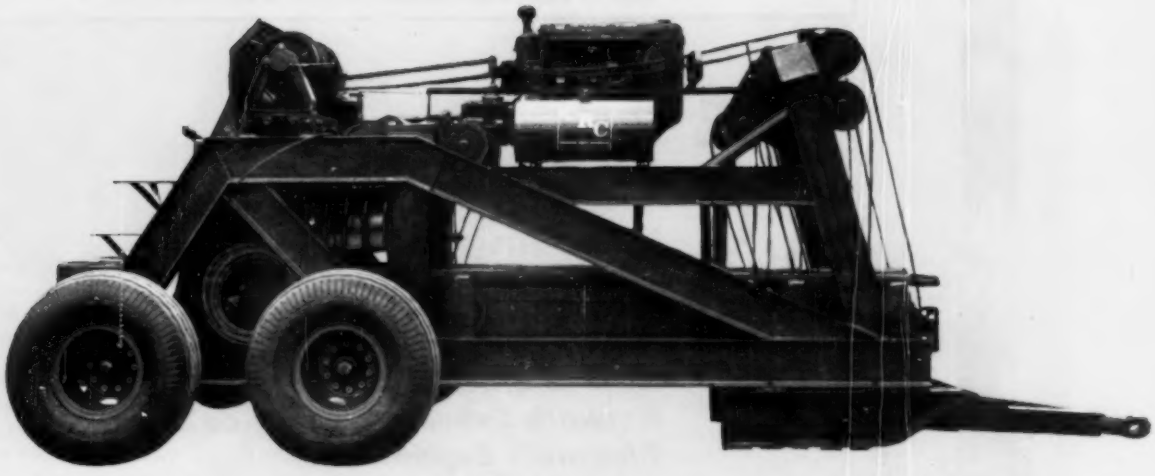

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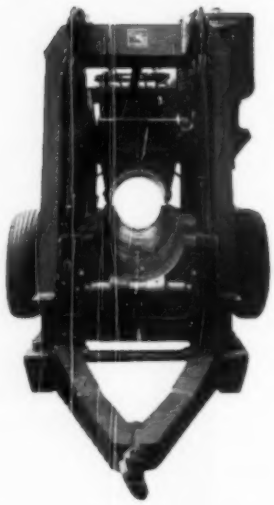

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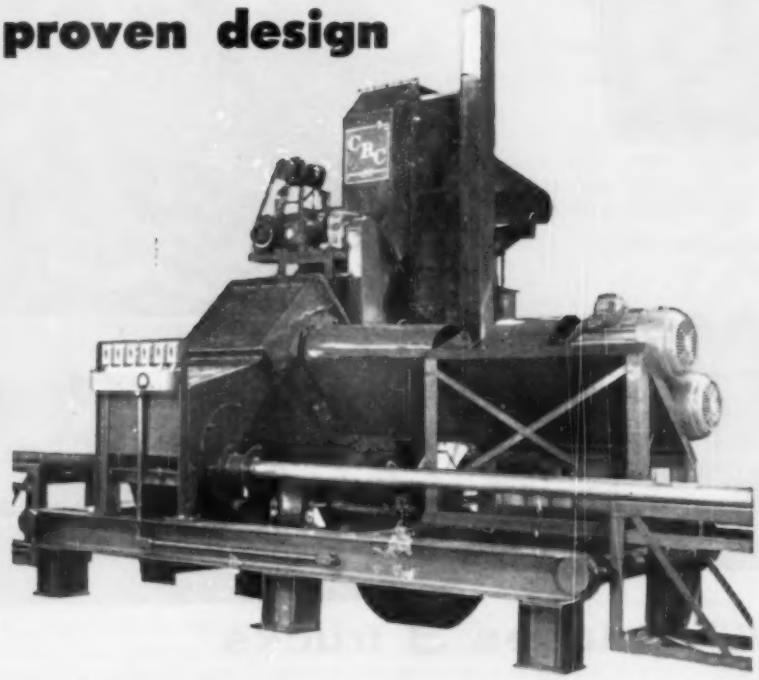

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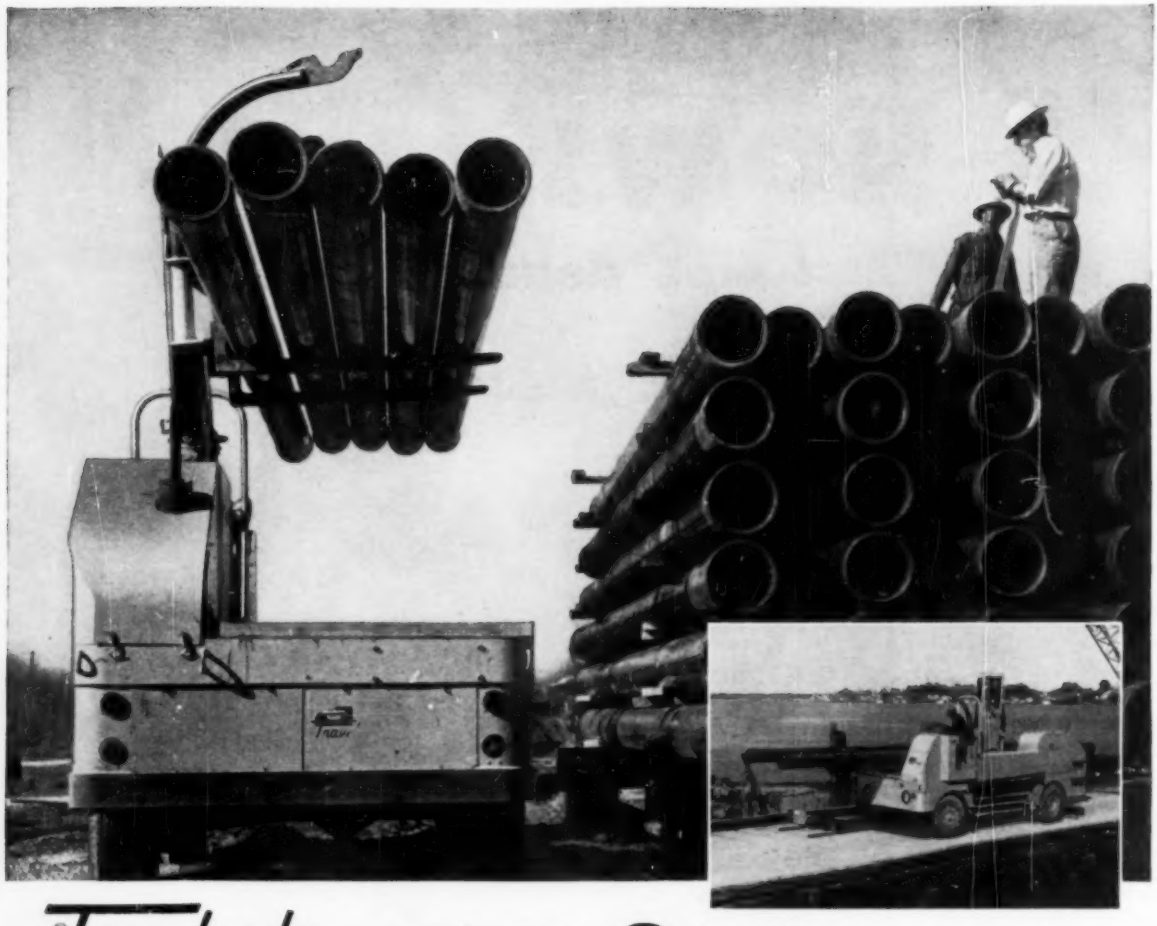

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Since the company operates 24 hours, 7 days per week, the cost savings are substantial. Moreover, 6 more workers were made available without increasing payroll, and two less mechanized units require maintenance. "This machine is by far the finest that I have seen for handling pipe. It has doubled our capacity with less labor," says Mr. J. E. Kyle, Jr., Vice President.

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P 615.91

How River Crossings are Surveyed and Designed

Dan Tindall

Tennessee Gas Transmission Company, Houston, Texas

ALMOST all obstacles and problems inherent in submarine river crossings can be found on the Mississippi River. The current is deep, swift, and whimsical, and the banks and approaches for the most part are difficult. A small variation in upstream conditions can produce extreme problems downstream.

This wide range of difficulties led one engineer to describe a successful crossing of the Mississippi as one "that hasn't failed yet." This is no idle jest. The various pipeline companies that have spent millions of dollars laying lines across the stream keep their collective fingers crossed, knowing full well that the vagaries of the river can make short work of any crossing.

This is why so many different methods of crossing have been tried and are in service today. Some companies have laid straight across; others have looped up or down stream. Lines have been laid directly on the river bed; others have been laid under a minimum of 25 ft of backfill. Most engineers disagree as to the best method of crossing the river, and this subject is controversial even within the various companies.

But because of the universality of problems and wide range of conditions found on the Mississippi, we will limit this discussion to methods used in crossing this particular river. As a matter of fact, we will go even further and limit it to methods Tennessee Gas Transmission Company has used in the past, acknowledging that other companies and other engineering departments have developed methods that may prove more "successful" than our own. We will simply show *how* Tennessee Gas has surveyed and designed its own crossings.

PRELIMINARY SURVEYS

One writer has stated that three factors govern the route of a pipeline running from the Gulf Coast area to the eastern portion of the U. S.

They are:

1. **Where it starts.**
2. **Where it terminates.**
3. **Where it crosses the Mississippi.**

As a matter of fact, perhaps the most important factor in the longevity of any crossing is its location, and the prime requisite for a successful crossing is to designate a crossing site reasonably close to the proposed route of the line that, by its history, shows that the bottom and banks are fairly stable. To do this, we contact various government agencies and compile a history of the river in sections near the proposed route of the line. The U. S. Corps of Engineers is particularly helpful, and the many hydrographic maps, quadrangle sheets, and both old and new aerial survey maps are valuable for this purpose.*

From this information, composite river study maps are made and a tentative location is selected. The next step is to make a preliminary design to determine the most desirable type of crossing. It may be an aerial span, a stress-free submerged, or a catenary crossing.

PLOTTING CONTOUR AND PROFILE MAPS OF CROSSING SITE

Before a decision can be made on the type of crossing to install, ground work must be completed in the field. A contour map must be plotted from which profiles of the proposed crossing can be made. The technique is similar to land work except that a boat with fathometer or sounding line replaces the level rod. Moreover, all the points must be triangulated to determine their distance along the range lines.

First task of the field party is to establish a base line along one of the banks. (See Fig. 1.) Generally, this line should be parallel to the stream and preferably on the levee for maximum visibility. Tack points are established on 100-ft intervals, with "plusses" starting from the center line of the proposed crossing.

Two transits are used. One is stationary, aimed along a range line (the angle is turned off the base line). The other is spotted at some tack point on the base line as far away as possible to give maximum accuracy in subsequent triangulation. The instrument man at the latter point keeps his transit trained on the boat as it maneuvers back and forth along the range line taking readings at proper intervals. When the boat centers on the cross hairs of the transit, which is aimed along the range line, the instrument man signals and the fathometer reading is recorded. At the same time, the distant transit records his angle with the base line. By simple triangulation, the distance along the range line can be calculated.

Of course, the extensiveness of this survey depends on the magnitude and type of crossing chosen. Other factors are the Corps of Engineers' specifications and the requirement of riparian owners in respect to right-of-way and necessary working space.

Once the base line has been established and the proposed route for the crossing has been selected, core borings are made for a soil or rock analysis to determine bearing and shear strength as well as side slopes for the ditch and approaches.

FEASIBILITY STUDIES

Regardless of other factors, experience and economics must be relied on to govern any crossing. There are many indeterminate factors that as yet cannot be calculated, and there are limitations in construction. For these reasons, most river crossing designs are compromises of good practice, sound engineering, and economics.

*This subject will be covered in more detail in a subsequent issue.

report of Cooper-Bessemer

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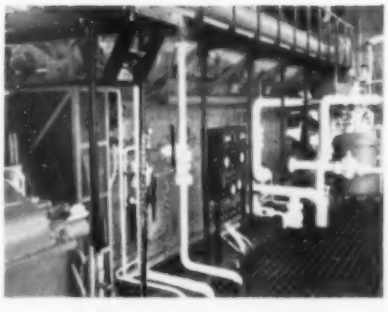
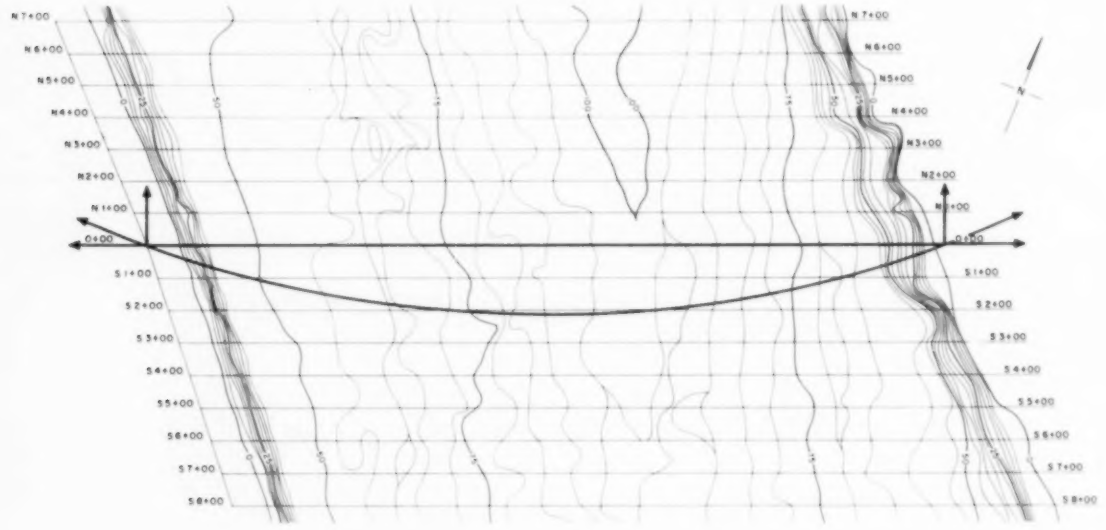


In Gulf Interstate's satellite station near Stanton, Kentucky, this Cooper-Bessemer centrifugal compressor is driven by a 4-cycle Cooper-Bessemer engine operating economically on natural gas from the pipeline.

TYPICAL CONTOUR STUDY OF A RIVER



FLOW CALCULATIONS

Flow calculations for the line will not be discussed because flow rates are the same as for other portions of the pipeline.

PIPE WALL THICKNESS

Generally, this is governed by the ASA Code for Pressure Piping. On occasion, however, companies (including Tennessee Gas) have elected to lay extremely heavy wall pipe to gain needed negative buoyancy and additional strength. TGT has two 16-in. lines of 1¼-in. wall thickness spanning the Mississippi near Greenville, which were laid in a catenary directly on the river bottom. They have been in service eight years, successfully withstanding scouring and impact loads from debris. Aside from minimum code requirements, variations in wall thickness are determined by experience.

VELOCITY OF WATER

Inasmuch as the velocity of the water affects laying, ditching, and backfill, it is advisable to calculate this factor. Fig. 2 shows characteristic curves for stream velocities as used by the U. S. Corps of Engineers. Note that mean velocity is reached at 0.6 the depth of the water with surface velocity running 115 percent of this figure. Velocity near the bottom is about 70 percent of the mean velocity.

NEGATIVE BUOYANCY

There is considerable controversy over what is desirable negative buoyancy. Involved in this are:

Mechanics of backfill,
"Healing" properties of the backfill material,
Specific gravity of the backfill material, and
Depth of backfill.

Obviously, if a line is subject to movement during the period of backfill where sand is the primary material, the line likely will be "jacked" up out of the ditch as the sand edges under the pipe during movement.

"Healing" refers to the setting or compacting of the backfill material. If it quickly reaches a state somewhat similar to undisturbed soil, the vacuum and skin effect it produces likely will hold the pipe in place regardless of the specific gravity of subsequent backfill material.

The specific gravity of the backfill material is of greatest consideration in computing negative buoyancy. Where the backfill is accomplished by silting, many companies attempt to estimate the consistency of the silt, clay-water mixture that will flow in on the pipe and determine its specific gravity in order to insure that the specific gravity of the pipe will exceed this amount. But this can be expensive, because the cost of weight material runs high. First, there is the transportation problem: It costs money to haul the material to the site. Generally, the heavier the pipe, the heavier the equipment to handle it and the more elaborate the operation.

Actually, it is possible to "cheat" on this figure by dredging-in backfill. In this instance, only a relatively short length of the line is exposed at a time to the floatation effect of the backfill. The remainder of the line anchors the pipe in the immediate section of the fill until there is so much backfill over the pipe that it loses any tendency to float.

A short cut method developed by L. H. Peacock, engineer, Tennessee Gas Transmission Company, for calculating negative buoyancies of submarine lines is shown in Fig. 3 and the accompanying tables.

PERMISSIBLE BENDING DURING CONSTRUCTION

Fig. 4 through 17 show short cut methods of determining stress in bare steel pipe and minimum allowable radius to which concrete coated pipe may be bent. These figures are based on company specifications set at 2500 psi as the maximum allowable fiber stress for concrete. Several examples are worked on the drawings.

HOW TO CALCULATE AN APPROXIMATE CATENARY CROSSING

In the calculation of a river crossing to form the approximate shape of a catenary, the parametric form is used and

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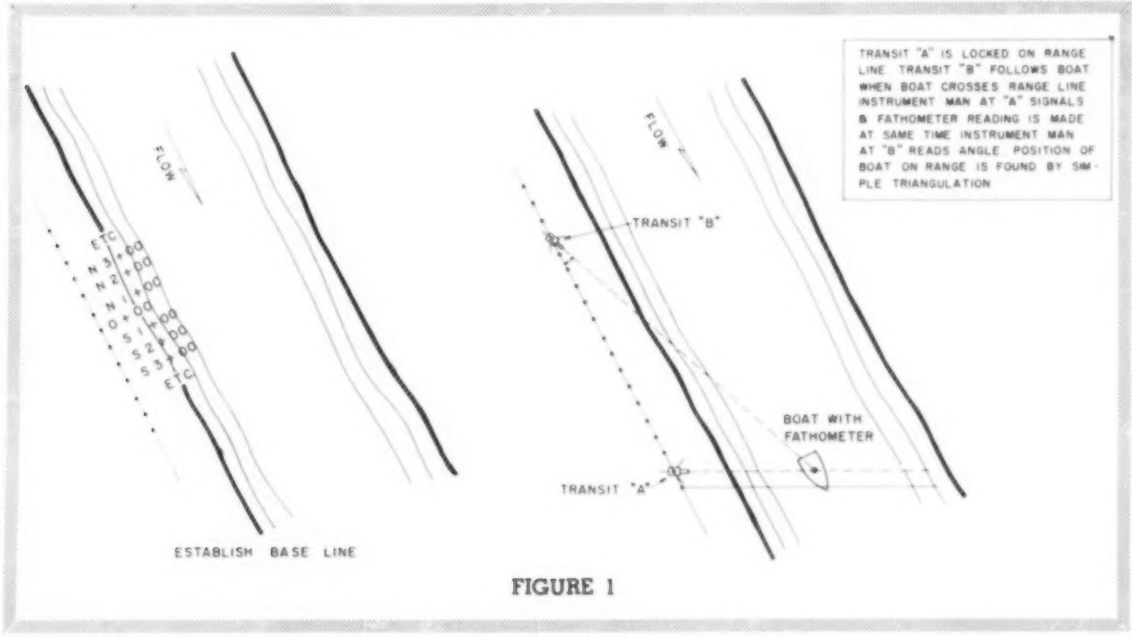

TRANSIT "A" IS LOCKED ON RANGE LINE. TRANSIT "B" FOLLOWS BOAT WHEN BOAT CROSSES RANGE LINE INSTRUMENT MAN AT "A" SIGNALS B. FATHOMETER READING IS MADE AT SAME TIME INSTRUMENT MAN AT "B" READS ANGLE. POSITION OF BOAT ON RANGE IS FOUND BY SIMPLE TRIANGULATION
FLOW
ETC
N 3 + 00
N 2 + 00
N 1 + 00
0 + 00
S 1 + 00
S 2 + 00
S 3 + 00
ETC
ESTABLISH BASE LINE
FLOW
TRANSIT "B"
BOAT WITH FATHOMETER
TRANSIT "A"

FIGURE 1

assumptions are made for purpose of calculation that tend to deviate this from the theoretical or precise form of the hyperbolic curve.

By definition, a catenary must have a uniform load, as in a free swinging cable. Forces acting on a line due to velocity are in the center of the river and decrease as the line approaches the banks. For simplicity and safety, we calculate this force as being maximum river velocity and consider this force to be acting along its entire length. Even with this total load, this force is not sufficient against the negative weight of the pipe to force this into the shape of a catenary. The line must be laid in this position.

ENGINEERING DURING CONSTRUCTION

During initial construction, the line is restaked by the field party. Control points are established for visual alignment during construction along with radio or signal controls. Day-by-day checks are made as to the location of the dredge or other excavating equipment. Soundings are taken periodically to determine proper ditch depth.

Where the river crossing is laid in an approximate catenary, visual control is necessary. One method of achieving this is shown in Fig. 22.

Points of tangency are established at A and A′ and monuments or flags are set at B_1, B_2, B_3, etc., and B′, etc. Two sets of range markers on either side of the river complete the shore installation. During construction it is necessary only to line up proper range markers to determine the proper location in the river.

After the preliminary construction is complete and laying operation is ready, the field survey engineers make a material inventory of pipe, weights, fittings, etc., in construction note form. If weights are used they are spaced by the engineers and at that time a check is made of the lengths between overbends and sags to make certain that the fabricated section will fit the excavated ditch. It is also the duty of the field engineers to check the concrete or asphalt coating for breakage and to watch for any excessive defection in the line during the laying operation.

Once the pipe has been placed in the ditch, a "top of pipe" profile is made—using a sounding line or electronic fathometer—to determine if the line is to proper grade before actual acceptance is made by the company engineer. A final alignment survey is then made to tie down the actual location of the pipe in respect to property corners and all other tangible reference points.

During this period the contractor is backfilling the ditches and approaches. After completion, a final profile is made to make certain that the ditches and approaches have been filled to original grade and that no mound or holes were left in the bed of the river.

Depending on stabilization of the banks, a design is made to install or construct necessary bulkheads, levees, or sand bagging for protection against bank erosion.

REFERENCE AND INSPECTION

We now come to the final phase of river crossing survey and design. The field party sets permanent concrete reference monuments showing exact location of line and elevation or datum used for construction. This is extremely valuable in the event of a second crossing at some later date.

Periodic surveys are made from time to time to determine and correct immediately any scour in the bed or erosion of the banks. Constant surveillance and immediate attention can preserve the line for many successful years of operation.

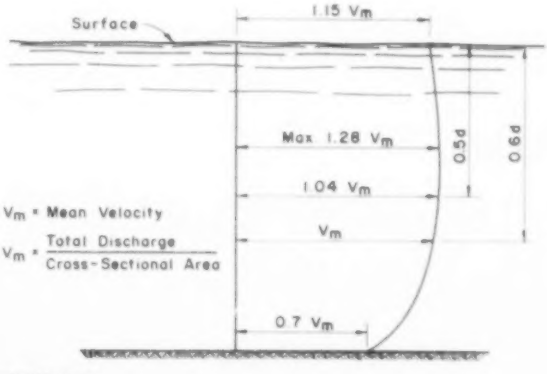


FIGURE 2

FIGURE 3

CALCULATION FOR MARINE PIPING WEIGHTS

Location _____ Date _____

Reported By _____ Checked By _____

Pipe 24 " OD x .937" wt., 231.04 lb/LF Negative Bouyancy 166 %
Water: (Fresh @ 62.45 lb/cu ft) Density of Matl to be Used 150 lb/cu ft
(Salt @ 64.0 lb/cu ft)
OD of pipe 24.00 "
Double wrap-coating .375"
Diameter (add) 24.375"

Table 1 Area 3.2406

Table 2: wt wrap-coating 11.4 lb/LF; wt of pipe 231.04 lb/LF; W (add) 242.44 lb/LF

Effective additional wt required:

Bouyancy:
Area x lb/cu ft water x % Neg. Bouy
B 336.21 lb/LF

Table 3: We (B - W) 93.77 lb/LF; E (efficiency) 45.39 %

ADDITIONAL WEIGHT REQUIRED (We / E) 206.59 lb/LF

CAST IRON WEIGHTS

Spacing:

Lb of Each Weight
Additional Wt Reqd

_____ ft

Wae:
Center to Center

_____ "

CONCRETE WEIGHTS

Spacing:

Lb of Each Weight
Additional Wt Reqd

_____ ft

Wae:
Center to Center

_____ "

CONCRETE COATING

Table 4 Use: 217 lb/LF
2" Thk

Diameter:
Pipe = 24.00 "
Wrap-coating .375"
Concrete = 2"
(Add) = 28.375"

Weight:
W 242.44 lb/LF
Concrete 217.00 lb/LF
Wc (Add) 459.44 lb/LF

Table 1 Area 4.3913

Bouyancy
Area x lb/cu ft water
Bc 274.46 lb/LF

NEGATIVE BOUYANCY:
Wc Bc 184.98 lb/LF
Wc / Bc 167 %

Maximum density of solution which can be displaced:

Bc / Area 104.63 lb/cu ft

TABLE 1. Areas

Diameter	CF/LF	Diameter	CF/LF	Diameter	CF/LF
8.625	0.4049	18.125	1.7917	28.875	4.5472
9.000	.4398	18.375	1.8414	29.125	4.6263
10.750	.6302	18.625	1.8920	29.375	4.7067
11.000	.6597	18.875	1.9433	29.625	4.7869
11.125	.6753	19.125	1.9949	29.875	4.8679
11.250	.6904	19.375	2.0474	30.000	4.9088
11.500	.7214	19.625	2.1106	30.125	4.9496
11.750	.7530	19.875	2.1544	30.375	5.0319
12.000	.7854	20.000	2.1817	30.625	5.1152
12.250	.8184	20.125	2.2090	30.875	5.1997
12.500	.8522	20.375	2.2642	31.125	5.2839
12.750	.8867	20.625	2.3201	31.375	5.3690
13.000	.9218	20.875	2.3767	31.625	5.4548
13.125	.9396	21.125	2.4340	31.875	5.5412
13.250	.9575	21.375	2.4919	32.125	5.6285
13.375	.9757	21.625	2.5506	32.375	5.7171
13.500	.9940	21.875	2.6099	32.625	5.8057
13.625	1.0125	22.000	2.6398	32.875	5.8949
13.750	1.0312	22.125	2.6699	33.125	5.9847
13.875	1.0500	22.375	2.7306	33.375	6.0752
14.000	1.0690	22.625	2.7919	33.625	6.1663
14.125	1.0882	22.875	2.8540	33.875	6.2590
14.250	1.1075	23.125	2.9167	34.125	6.3517
14.375	1.1271	23.375	2.9801	34.375	6.4450
14.500	1.1467	23.625	3.0442	34.625	6.5389
14.625	1.1666	23.875	3.1090	34.875	6.6335
14.750	1.1866	24.000	3.1416	35.125	6.7287
14.875	1.2068	24.125	3.1744	35.375	6.8258
15.000	1.2272	24.375	3.2406	35.625	6.9222
15.125	1.2477	24.625	3.3074	35.875	7.0196
15.250	1.2684	24.875	3.3749	36.125	7.1176
15.375	1.2893	25.125	3.4430	36.375	7.2163
15.500	1.3103	25.375	3.5119	36.625	7.3158
15.625	1.3316	25.625	3.5814	36.875	7.4167
15.750	1.3530	25.875	3.6517	37.125	7.5175
15.875	1.3745	26.000	3.6870	37.375	7.6190
16.000	1.3963	26.125	3.7226	37.625	7.7211
16.125	1.4182	26.375	3.7944	37.875	7.8238
16.250	1.4402	26.625	3.8661	38.125	7.9272
16.375	1.4625	26.875	3.9396	38.375	8.0324
16.500	1.4849	27.125	4.0131	38.625	8.1374
16.625	1.5075	27.375	4.0872	38.875	8.2429
16.875	1.5530	27.625	4.1620	39.125	8.3491
17.125	1.5991	27.875	4.2383	39.375	8.4559
17.375	1.6466	28.000	4.2760	39.625	8.5634
17.625	1.6943	28.125	4.3144	39.875	8.6724
17.875	1.7426	28.375	4.3913	40.125	8.7814
18.000	1.7672	28.625	4.4689	40.375	8.8910

TABLE 2. Double Wrap-Coating .375-in. Thick (3/16-in.)

Pipe size	Wrap-coating wt/lin ft	Pipe size	Wrap-coating wt/lin ft
8 5/8"	4.12#	20"	9.52#
10 3/4"	5.14#	22"	10.48#
12 3/4"	6.08#	24"	11.40#
14"	6.68#	26"	12.36#
16"	7.62#	28"	13.32#
18"	8.56#	30"	14.22#

TABLE 3. Percent Efficiency

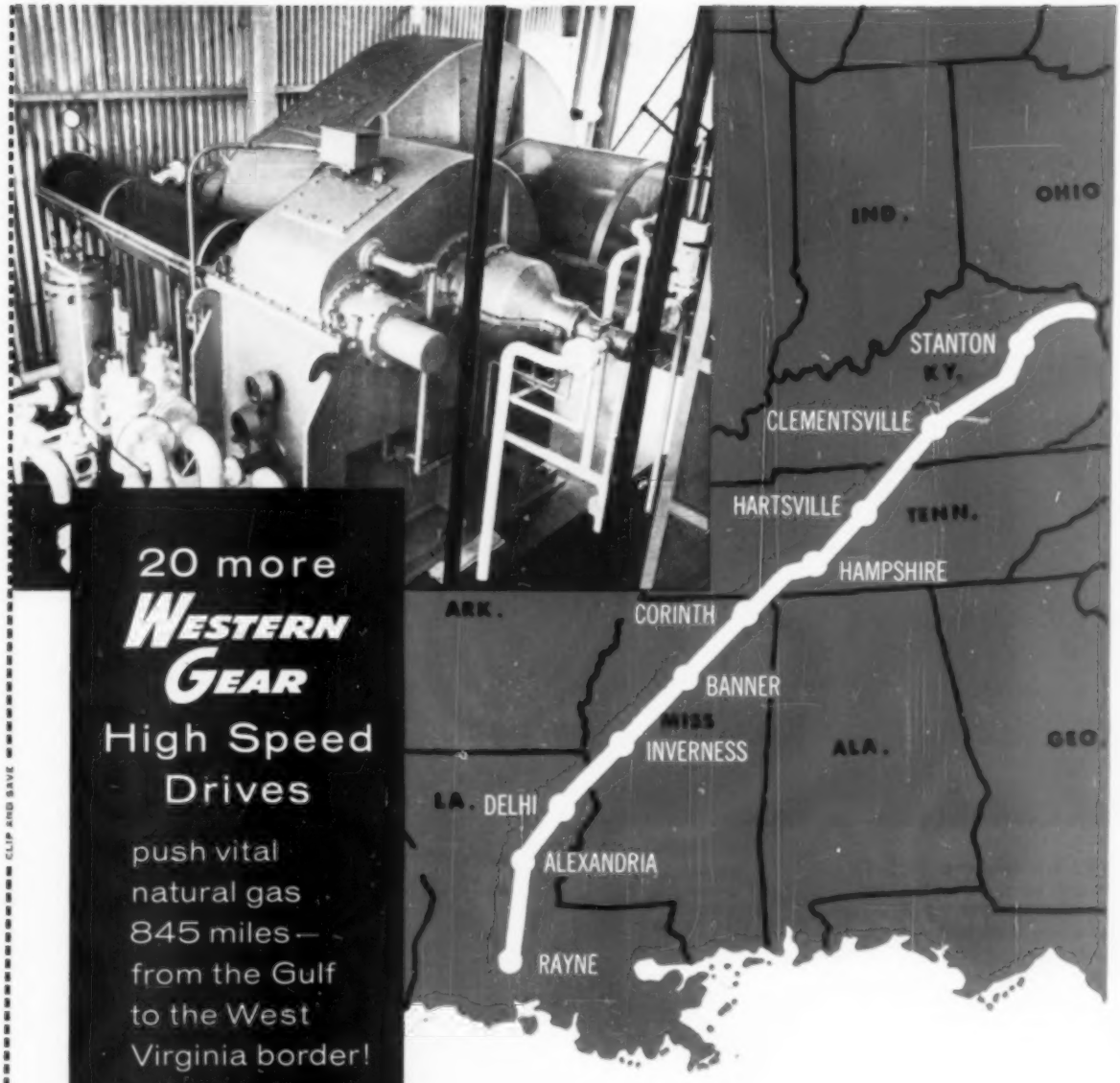
	140# Per cu ft		165# Per cu ft		190# Per cu ft		
N. B.	Fresh	Salt	Fresh	Salt	Fresh	Salt	N. B.
1.15"	48.70	47.43	56.48	55.39	62.20	61.26	1.15"
1.18"	47.42	46.06	55.38	54.23	61.25	60.25	1.18"
1.20"	46.47	45.14	54.58	53.46	60.56	59.58	1.20"
1.25"	44.24	42.86	52.69	51.52	58.92	57.90	1.25"
1.30"	42.01	40.57	50.80	49.58	57.27	56.21	1.30"
1.35"	39.79	38.29	48.91	47.64	55.63	54.53	1.35"
1.40"	37.55	36.00	47.01	45.70	53.99	52.84	1.40"
1.45"	35.32	33.72	45.12	43.76	52.34	51.16	1.45"
1.50"	33.09	31.43	43.23	41.82	50.70	49.47	1.50"
1.55"	30.86	29.14	41.34	39.88	49.05	47.79	1.55"
1.60"	28.63	26.86	39.44	37.94	47.41	46.11	1.60"
1.65"	26.40	24.57	37.55	36.00	45.77	44.43	1.55"

$$\text{Efficiency} = \frac{\text{Material Wt/Cu Ft} - (\%\ \text{N. B.} \times \text{Water Wt/Cu Ft})}{\text{Material Wt/Cu Ft}}$$

TABLE 4. Weights of Concrete Coating In Lb/Lin Ft

Thickness (in.)	16" Pipe Concrete			18" Pipe Concrete			20" Pipe Concrete			22" Pipe Concrete		
	140#	165#	190#	140#	165#	190#	140#	165#	190#	140#	165#	190#
1	53	62	71	59	69	80	65	76	88		83	96
1 1/8	59	70	81	66	78	90	73	86	99		94	109
1 1/4	67	78	90	74	87	101	82	96	111	89	105	121
1 3/8	74	87	100	82	97	112	91	107	123	99	117	134
1 1/2	81	96	110	90	106	122	99	117	135	109	128	147
1 5/8	88	104	120	98	116	133	108	128	147	118	139	160
1 3/4	96	113	130	107	126	145	117	138	159	128	151	174
1 7/8	103	122	140	115	135	156	126	149	171	138	162	187
2	111	131	151	123	145	167	136	160	184	148	174	201
2 1/8	119	140	161	132	155	179	145	171	197	158	186	214
2 1/4	127	149	172	140	166	191	154	182	209	168	198	228
2 3/8	135	159	183	149	176	202	164	193	222	178	210	242
2 1/2	143	168	194	158	186	214	173	204	235	189	222	255
2 5/8	151	178	205	167	197	226	183	216	248	199	234	270
2 3/4	159	187	216	176	207	239	193	227	261	209	247	284
2 7/8	167	197	227	185	218	251	203	239	275	220	259	299
3	176	207	239	194	229	263	212	250	288	231	272	313
3 1/8	184	217	250	203	240	276	223	262	302	242	285	328
3 1/4	193	227	262	213	251	289	233	274	316	253	298	343
3 3/8	202	238	274	222	262	302	243	286	330	264	311	358
3 1/2	210	248	286	232	273	315	253	298	344	275	324	373
3 5/8	219	259		242	285	328	264	311	358	286	337	388
3 3/4	228	269		251	296	341		323	372	297	350	403
3 7/8	237	280		261	307	354	285	336	387	308	363	419
4		291		271	319	368	296	348	401	320	377	434
4 1/8	256	302		281	331		306	361	416	331	391	450
4 1/4		313		291	343		317	374	431	343	404	466
4 3/8	275			302	355		328	387	445	355	418	482
4 1/2	284	335			368		339	400	461	367	432	498
4 5/8	294	347		322	380		351	413	476	379	446	514
4 3/4	304			333	392			426		391	461	530
4 7/8	314	370		343	405		373	440		403	475	547
5	324						385	453			489	

Thickness (in.)	24" Pipe Concrete			26" Pipe Concrete			28" Pipe Concrete			30" Pipe Concrete		
	140#	165#	190#	140#	165#	190#	140#	165#	190#	140#	165#	190#
1		104										
1 1/8		118										
1 1/4		132				142						
1 3/8		146				157						
1 1/2		160			150	172			185			
1 5/8	128	174			158	187			201			
1 3/4	138	188			176	203		189	217			232
1 7/8	149	203			189	218		203	234			249
2	160	217	232	172	203	234		217	250			
2 1/8	171	232	249	183	216	249		232	267		247	285
2 1/4	182	247	265	195	230	265	209	247	284			303
2 3/8	193	262	281	207	244	281	221	261	301		278	321
2 1/2	204	277	297	219	258	297	234	276	318			339
2 5/8	215	292	314	231	272	314	247	281	335	263	310	357
2 3/4	226	307	330	243	286	330	260	306	353			375
2 7/8	238	323	346	255	300	346	273	321	370		342	394
3	249	338	363	267	315	363	286	337	388	304	358	413
3 1/8	261	354	380	279	329	380	299	352	406		375	432
3 1/4	272	321	370	292	344	397	312	368	424	332	391	450
3 3/8	284	335	386	305	359	414	325	383	442	346	408	470
3 1/2	296	349	402	317	374	431	338	399	460		424	489
3 5/8	308	363	418	330	389	448	352	415	478	374	441	508
3 3/4	320	377	434	343	404	465	366	431	496	389	458	528
3 7/8	332	391	451	356	419	483	379	447	515	403	475	547
4	344	406	467	369	435	501	393	463	534	418	492	567
4 1/8	357	420	484	382	450	518	407	480	553	432	510	587
4 1/4	369	435	501	395	466	536	421	496	571	447	527	607
4 3/8	382	450	518	408	481	554	435	513	591	462	544	627
4 1/2	394	465	535	422	497	572	449	530	610	477	562	647
4 5/8	407	480	552	435	513	591	464	546	629	492	580	667
4 3/4	420	495	570	449	529	609	478	563	649	507	597	688
4 7/8	433	510	587	463	545	628	492	580	668	522	615	709
5		525	605	476	561	646	507	597	688	537	633	729



20 more WESTERN GEAR High Speed Drives

push vital natural gas 845 miles—from the Gulf to the West Virginia border!

Twenty additional two-stage Western Gear high speed units are now being delivered to Gulf-Interstate Gas Company for the expansion of its 845 mile, 30 inch main pipeline to increase its capacity to 575 million cubic feet daily. The outstanding success of its first remote controlled satellite station at Stanton, Ky., has attracted the attention of the industry to this significart Gulf-Interstate development. Western Gear engineers were called upon to design a two-stage high speed gear drive to step up the 5000 H.P. natural gas operated 16 cylinder Cooper-Bessemer engine to power a centrifugal compressor at 6,055 RPM. Western Gear salutes Gulf-Interstate for its achievement and stands ready to assist other forward-looking companies in solving their mechanical drive problems. Experience gained since 1888 assures efficient and reliable performance of Western Gear designed equipment. For assistance write Western Gear Corporation, General Offices, P.O. Box 182, Lynwood, California.

"The difference is reliability" • Since 1888

5762

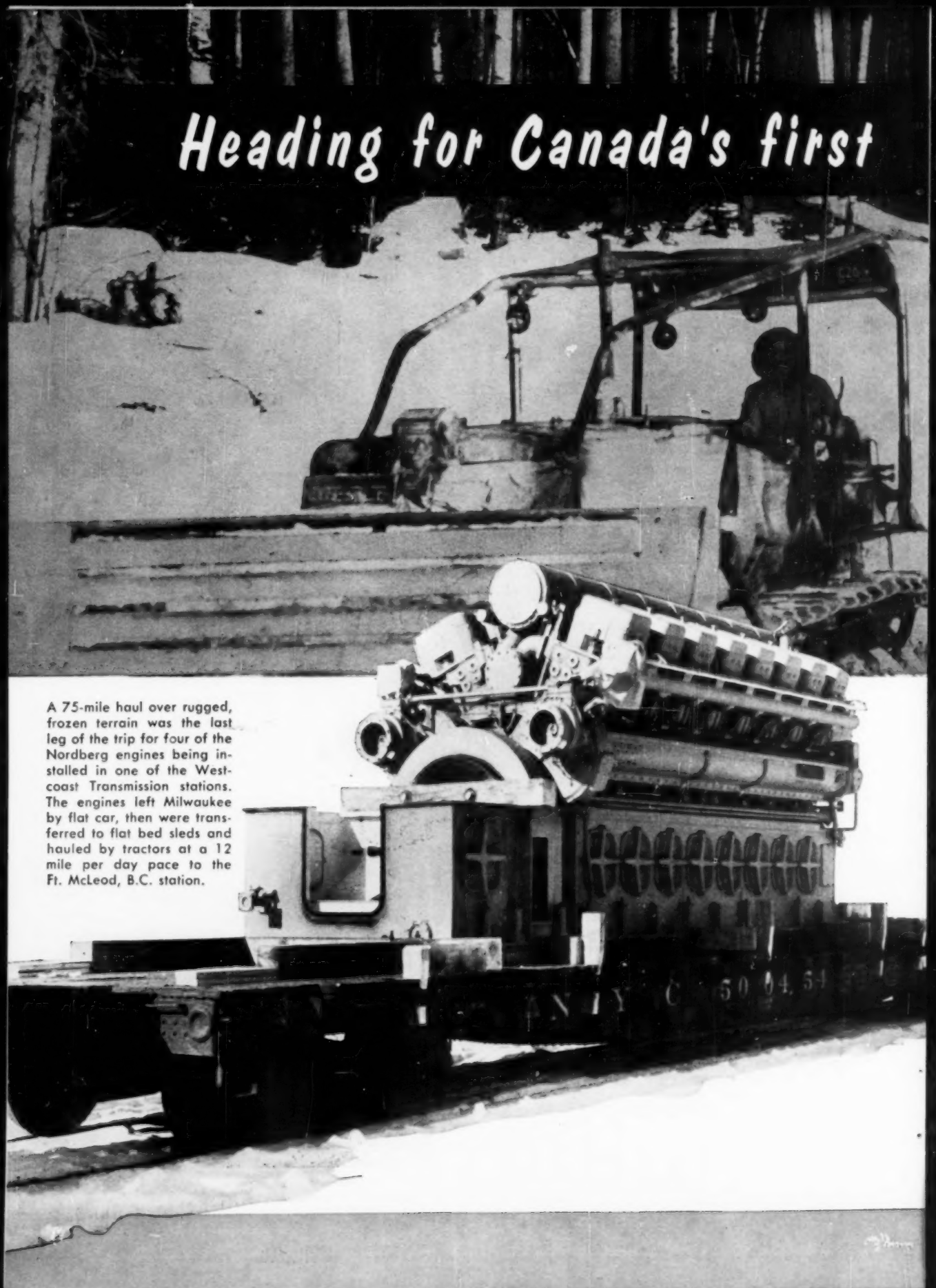
WESTERN GEAR Corporation

ENGINEERS AND MANUFACTURERS

PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.)
SEATTLE AND HOUSTON—REPRESENTATIVES IN PRINCIPAL CITIES

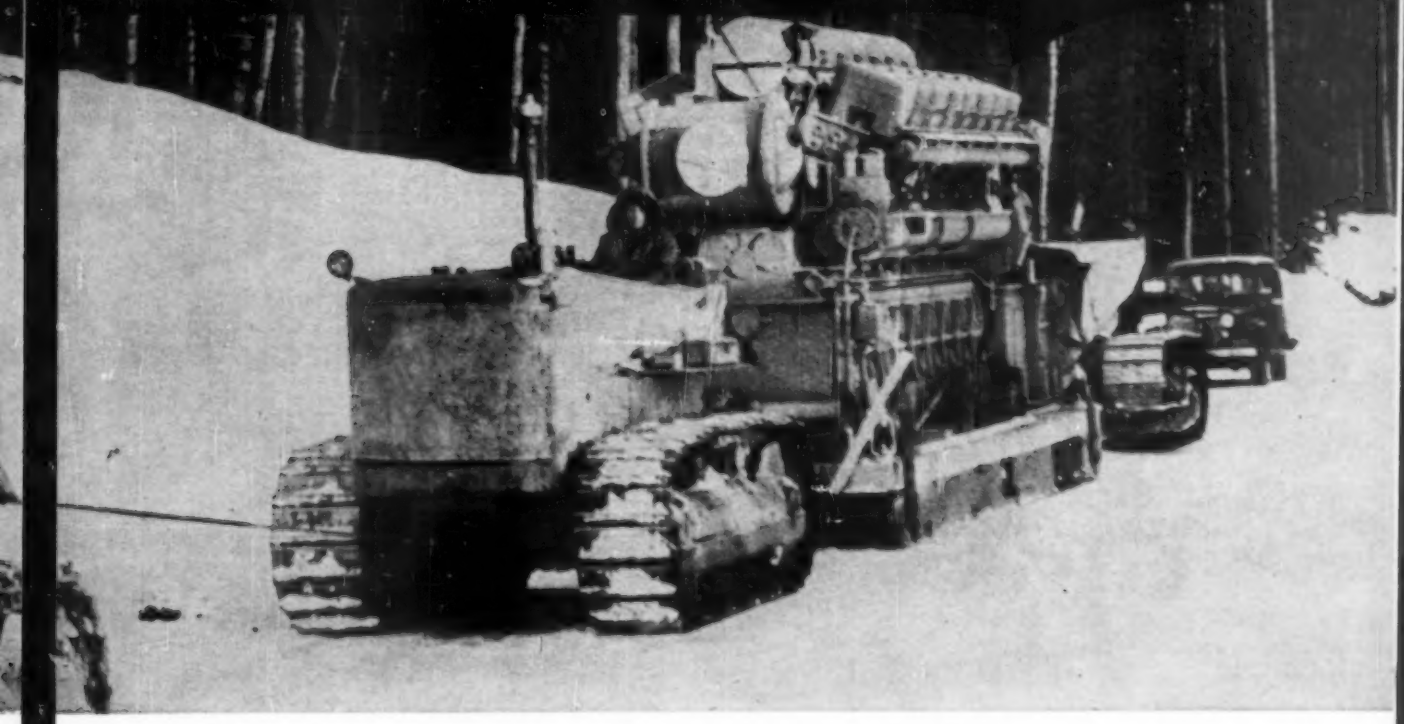
CLIP AND SAVE

Heading for Canada's first



A 75-mile haul over rugged, frozen terrain was the last leg of the trip for four of the Nordberg engines being installed in one of the West-coast Transmission stations. The engines left Milwaukee by flat car, then were transferred to flat bed sleds and hauled by tractors at a 12 mile per day pace to the Ft. McLeod, B.C. station.

"BIG-INCH" Gas Pipeline...



11 Nordberg Supairthermal® Gas Engines

to Power Compressor Stations for WESTCOAST TRANSMISSION CO., LTD.

Westcoast Transmission, Canada's first large-diameter gas pipeline, is expected to have gas flowing by fall, from the Peace River area of Alberta and British Columbia to the international border near Sumas, Washington.

Power for three of the compressor stations on this new 650-mile, 30" line will be furnished by eleven Nordberg 4-cycle V-type Supairthermal spark-ignition gas engines, rated 3550 bhp at 500 rpm. Each of these powerful, compact 16-cylinder engines are direct-connected to an integral 10 to 1 Nordberg speed increasing gear, to drive a DeLaval centrifugal gas compressor at 5000 rpm to produce the required pipeline "push."

These engines for Westcoast Transmission are typical of the increasing number of Nordberg Supairthermal gas engines being ordered and installed by major gas transmission companies . . . who have specified these engines on the basis of lower cost per installed horsepower, lower operating cost, and their ability to handle variations in volume and compression ratios with high efficiency at variable speeds.

Consult Nordberg on *your* next pipeline power problem . . . for natural gas, crude or products transportation. *Nordberg Mfg. Co., Milwaukee, Wisconsin.*

NORDBERG

DIESEL • DUAFUEL® AND SPARK-IGNITION GAS ENGINES

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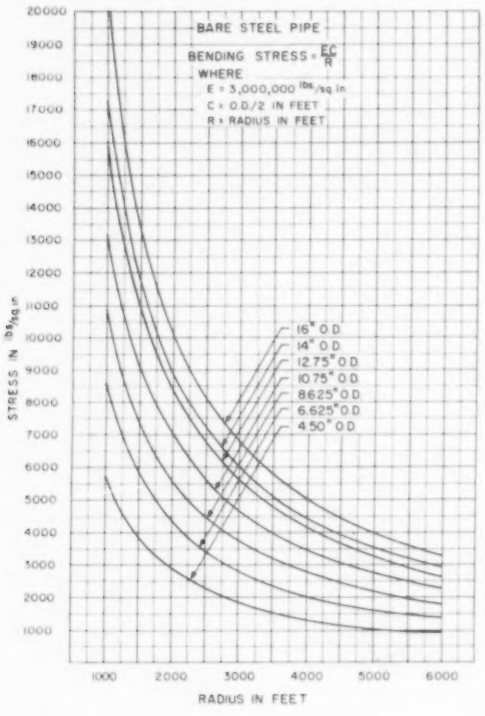


FIGURE 4

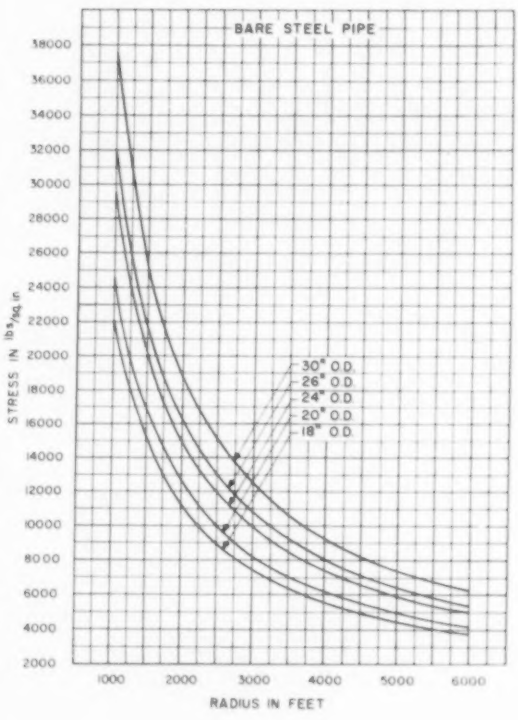
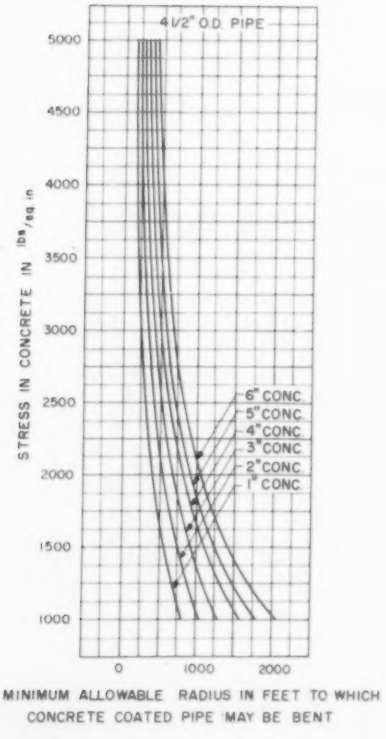


FIGURE 5



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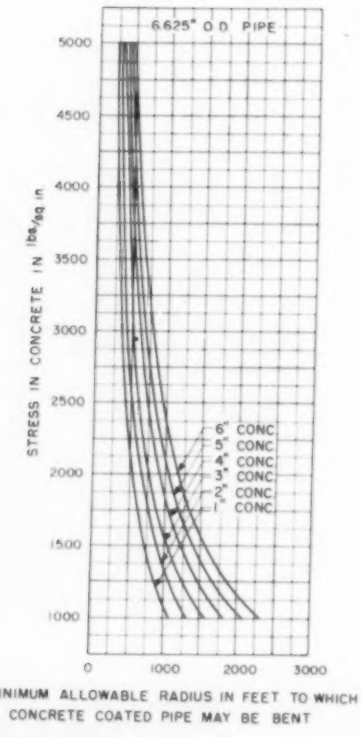

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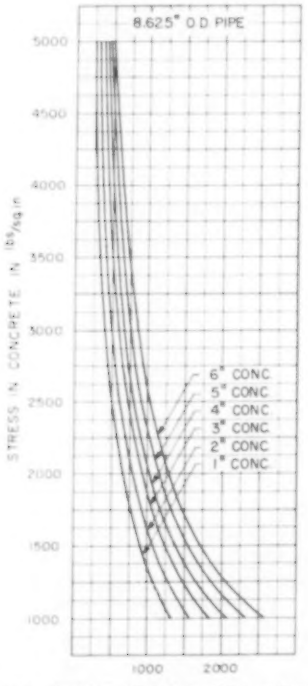

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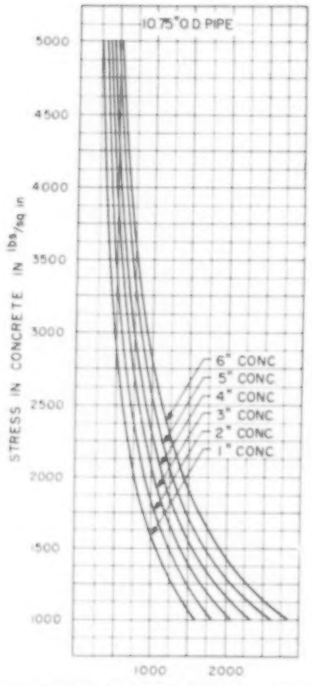
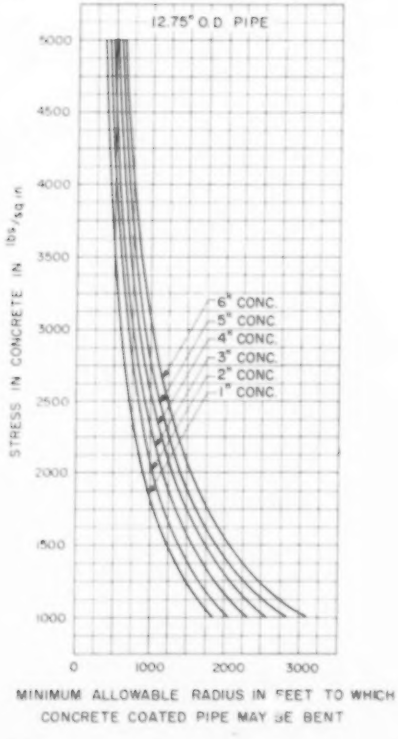


FIGURE 9



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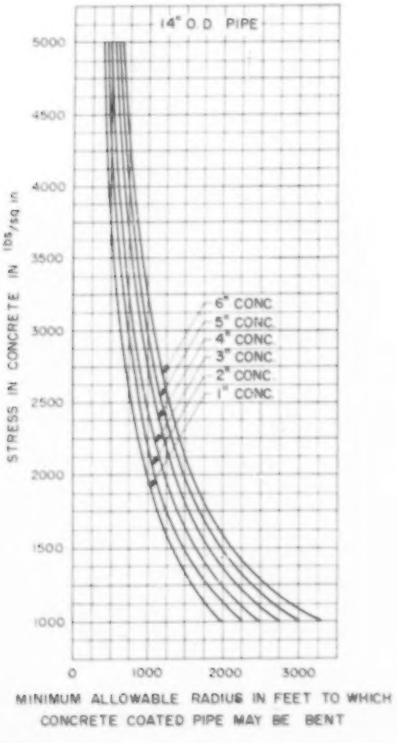


FIGURE 11

Pipeline industry's installed at

TURBINE CONTROL is centralized in one convenient, easily accessible location. One switch initiates automatic starting and stopping sequence for the drive system.

VERSATILITY of General Electric gas turbines permits installation of ducts and pipes below floor level. Higher rated gas turbine units provide lower over-all costs.

largest horsepower gas turbines Texas Eastern's Athens, Ohio station

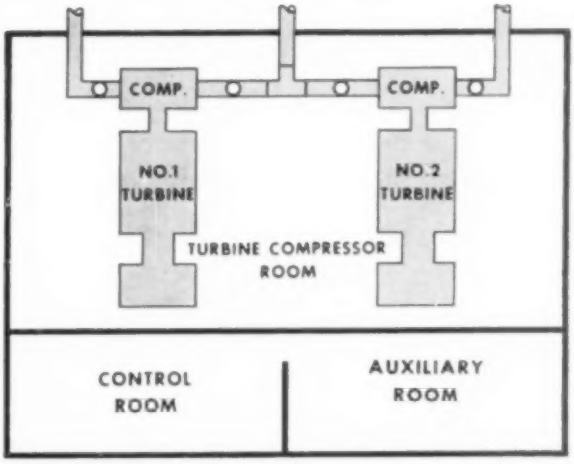
General Electric 7600-hp gas turbine drives provide lower dollars-per-horsepower installed cost, reduced operating costs with improved combustion system

Installed in Texas Eastern's Athens, Ohio station are two of the largest gas turbine units ever used to drive gas pipeline compressors. The new station, one of two duplicate stations put on stream by Texas Eastern, also has other unique features helping to provide efficient operation as well as station flexibility.

TURBINE HORSEPOWER: Each one of the two gas turbines in the General Electric drive system is a 7600-hp unit, largest ever used on gas pipeline applications. These new and larger units provide a lower $-per-horsepower installed cost because there is more horsepower in a given space. In addition, these General Electric turbines operate at better efficiency due to an improved combustion system.

STATION ARRANGEMENT: The new station's regenerator and air filters are located to the side of each turbine rather than axially in line with the turbines. This arrangement permitted straight through piping between compressor units with corresponding minimum pressure losses. A neat installation, with all pipes and ducts running below the floor, was also accomplished. There is no sacrifice in the ability to easily expand the station when load requirements demand it.

TO HELP YOU SOLVE your station drive requirements, General Electric makes available to you complete engineering services. As with the Texas Eastern installation, G-E engineers will help design and install the drive system that exactly meets your station requirements. Get complete information from your nearest General Electric Apparatus Sales Office—and meanwhile write for bulletin GEA-5516B, "Combustion Gas Turbines," to General Electric Co., Section 661-55, Schenectady, N. Y.



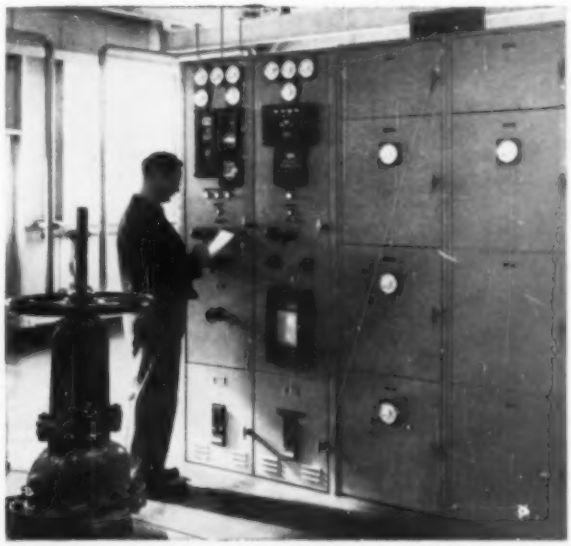
STRAIGHT PIPE reduces to a minimum pressure loss between units. Both of new stations utilize straight piping and, in addition, place station's air filters and regenerators to the side, rather than axially in line with the G-E gas turbines.

*Registered trade-mark of General Electric Co.

Engineered Electrical Systems for Pipeline Pumping

GENERAL ELECTRIC

MORE EFFICIENT General Electric gas turbine drive system was the result of close co-operation between Texas Eastern personnel and General Electric Company engineering services.



COMPACT, FACTORY ASSEMBLED General Electric Cabinetrol* panels centralize station's auxiliary equipment, are designed to take up minimum of station's valuable floor space.

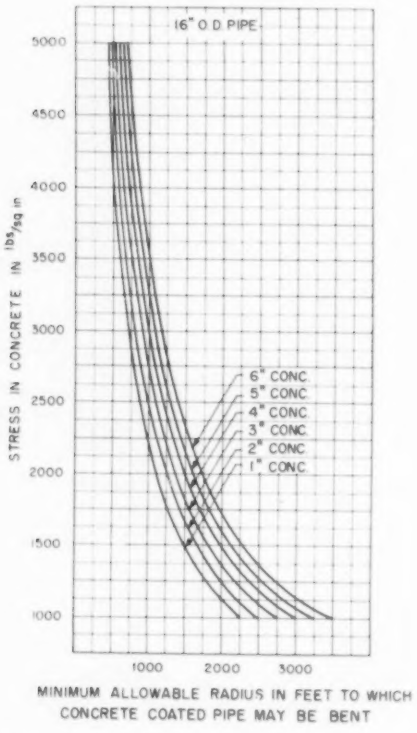


FIGURE 12

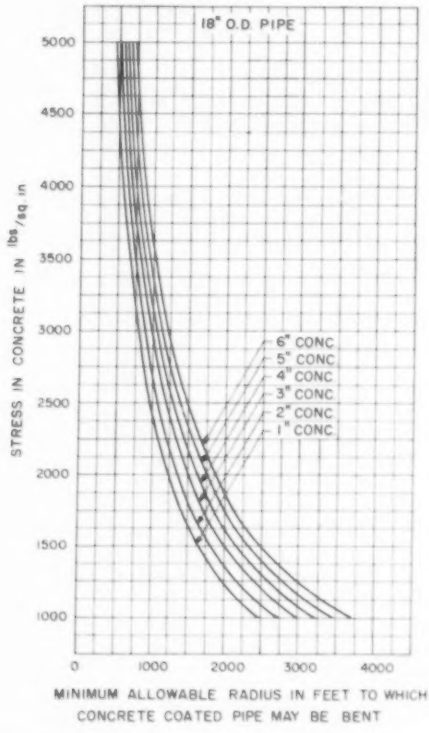


FIGURE 13

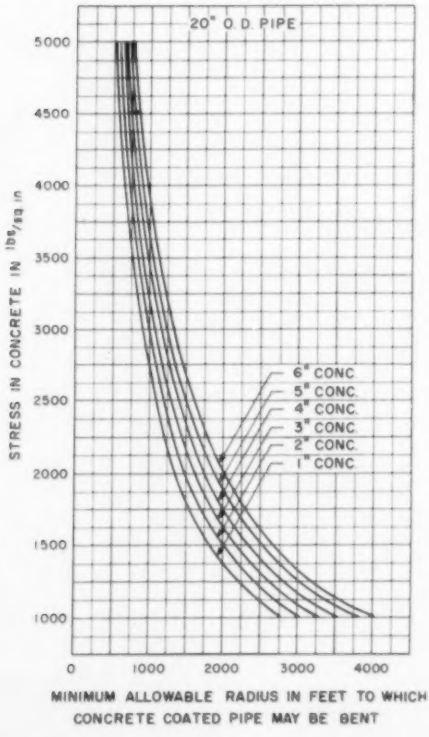


FIGURE 14

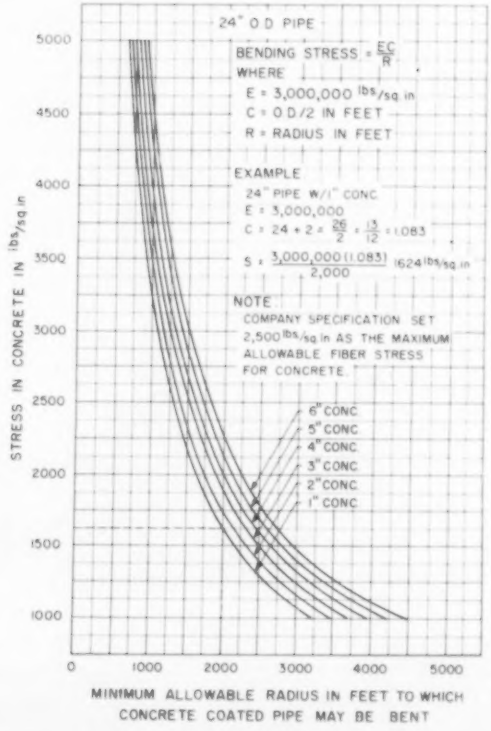


FIGURE 15

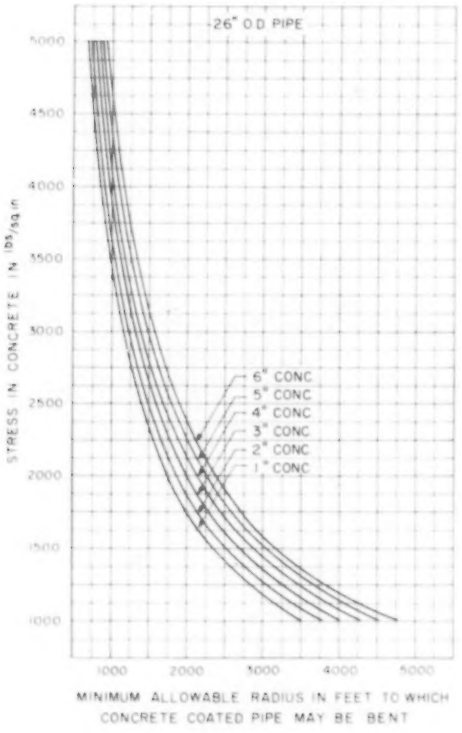


FIGURE 16

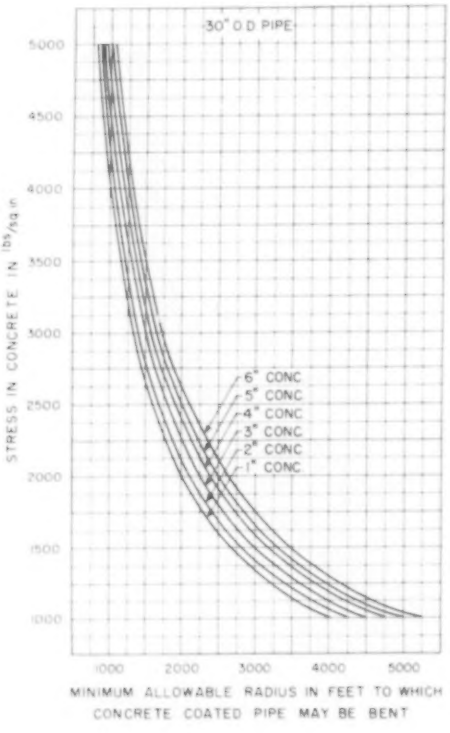


FIGURE 17

This is the derivation of the formulae used by Tennessee Gas in computing approximate catenary crossings:

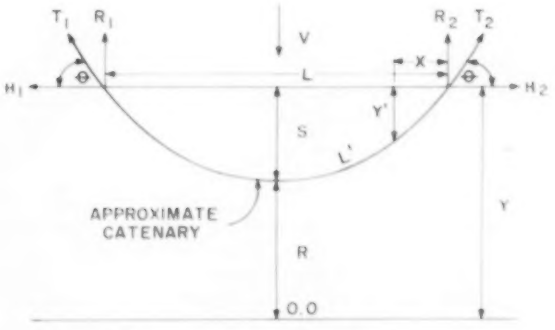


FIGURE 18

L = span length, ft
L' = length of arc, ft
Θ = angle of approach
T = line tension, lb
S = sag length, ft
V = water velocity, fps
Y = distance from directrix to base line

Effective load on pipe due to current = .75 (outside diameter) (density) (velocity head).

On river crossings "L" is known and Θ is given a value to fit the topography at the approaches.

$$R_1 = R_2 = \frac{\text{Effective load (L)}}{2}$$

$$T_1 = T_2 = \frac{R_1}{\text{Sin}\,\Theta}$$

$$H_1 = H_2 = T_1(\text{Cos}\,\Theta)$$

$$\text{Parameter} = \text{Radius} = \frac{H_1}{\text{Effective load}}$$

Solve for Hyperbolic Cosine (or Cosh)

$$\text{Cosh}\,X = \frac{L}{2R}$$

$$Y = R(\text{Cosh}\,X)$$

$$S = Y - R$$

To check the value of S use

$$S = R\left(\text{Cosh}\,\frac{L}{2R} - 1\right)$$

Calculate L'

$$L' = R\left(\text{Sinh}\,\frac{L}{2R}\,.2\right)$$

Calculate 100' increments in order to plot catenary using

$$Y' = R\left(\text{Cosh}\,\frac{X}{R} - 1\right)$$

where X is horizontal distance shown.

There are alternate methods where known factors other than L and Θ are used.[1]

In calculating the stress level on a crossing of this type, we consider three different stresses; S_b, the stress due to bending; S_c, the stress due to the current and S_{1p}, the stress due to longitudinal pressure. To insure an added factor of safety we consider these stresses to be acting simultaneously and additive. However, there are several schools of thought on this subject.

1. **Stress due to bending:**

$$S_b = \frac{E\,C}{R}$$

where

E = modulus of elasticity

$C = \frac{\text{OD of pipe in ft}}{2}$

R = radius in ft

2. **Stress due to current:**

$$S_c = \frac{T}{A}$$

where

T = tension in pipe, lb

and

A = area of steel in pipe, sq in.

3. **Stress due to internal pressure:**

$$S_{1p} = \frac{P\,A'}{A}$$

where

P = internal pressure, psi

A = flow area, sq in.

and

A' = steel area, sq in.

Example:

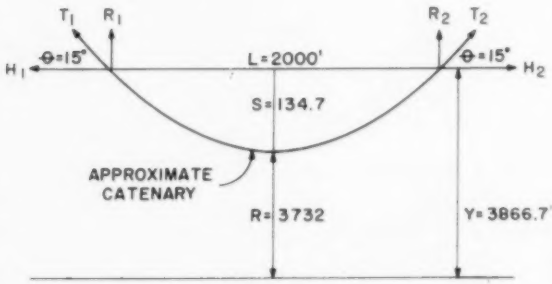


FIGURE 19

Water velocity = 5 ft per second

Pipe = 24 in. OD with 0.937 wt. It is 5LX – 42 line pipe with 2-in. of concrete coating.

Span length is 2000 ft and the angle Θ is 15 deg.

First solve for effective current load:

$$\text{Effective load} = (.75)\,(2.33)\,(62.5)\left(\frac{5^2}{2(32.2)}\right) = \text{approx. } 42.5$$

Effective load is 42.5 lb/lineal ft

Solve for reactions R_1 and R_2:

$$R_1 = R_2 = \frac{42.5\,(2000)}{2} = 42{,}500 \text{ lb.}$$

Resolve reactions into vertical components:

$$T_1 = T_2 = \frac{42{,}500}{\text{Sin } 15^\circ} = \frac{42{,}500}{.25882} = 164{,}207 \text{ lb.}$$

Resolve reactions into horizontal components:

$H_1 = H_2 = (164{,}207)\,(\text{Cos } 15^\circ) = (164{,}207)\,(.9659) = 158{,}608$ lb.

The Parameter = Radius

$$R = \frac{158{,}608}{42.5} = 3732 \text{ ft.}$$

To solve for Y first find the Hyperbolic Cosine, Cosh X

$$\text{Cosh } X = \frac{1000}{3732} = .26795$$

From hyperbolic tables cosh $X = 1.0361$

$$Y = (3732)\,(1.0361) = 3866.7 \text{ ft.}$$

Find the Sag:

$$S = Y - R = 3866.7 - 3732 = 134.7 \text{ ft.}$$

Check the sag:

$$S = 3732\,(\text{Cosh } \frac{1000}{3732} - 1)$$

$$= 3732\,(.0361) = 134.7$$

Calculate arc length:

$$L' = 3732\,(\text{Sinh } \frac{1000}{3732} \times 2)$$

$$= 3732\,(.2712 \times 2) = 2024.6 \text{ ft.}$$

From the profile we find that in order for the pipe to assume a natural sag at the approach, we must subject it to an 1800 ft radius curve. The radius of the catenary and the radius of the natural sag must be resolved into a common radius for calculating bending stress.

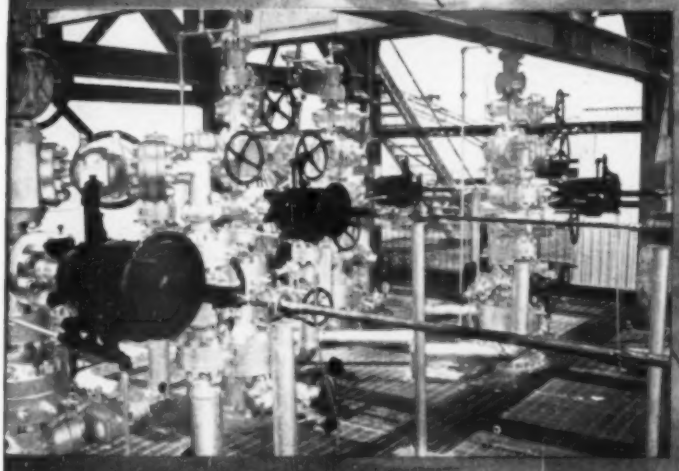
Use two radii: $R_1 = 1800$ ft and $R_2 = 3732$ ft and assume a 1000 ft cord.

$$\text{Deflection} = R_2 - \tfrac{1}{2}\sqrt{4R_2^2 - C^2}$$
$$= 3732 - \tfrac{1}{2}\sqrt{4(3732)^2 - 1000^2}$$
$$= 3732 - \tfrac{1}{2}\sqrt{34{,}699{,}296}$$
$$= 3732 - 3698$$
$$R_2 = 34 \text{ ft.}$$
$$\text{Deflection} = 1800 - \tfrac{1}{2}\sqrt{4(1800)^2 - 1000^2}$$
$$= 1800 - \tfrac{1}{2}\sqrt{11{,}960{,}000}$$
$$= 1800 - 1729$$
$$R_1 = 71 \text{ ft.}$$

for that big one off shore

E-I-M

stands the Test...



It's just like fishing with a heavy test line when you install E-I-M Valve Controls. You can be sure that the well won't get away from you because E-I-M has a record of safety and dependability. Our engineers can solve your transmission problems with E-I-M Valve Controls for oil or gas lines off shore or across the continent.

The Pure Oil Company's platform in Rollover Field, 9 miles off the Louisiana coastline, has four producing wells, each using an E-I-M Valve Control for maximum safety to protect personnel and the platform.

E-I-M Company INCORPORATED

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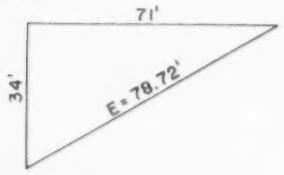
valve controls • speed reducers • cooling tower drives • control valves



$$Z = \sqrt{71^2 + 34^2}$$
$$= \sqrt{6197}$$
$$= 78.72 \text{ ft.}$$

FIGURE 20

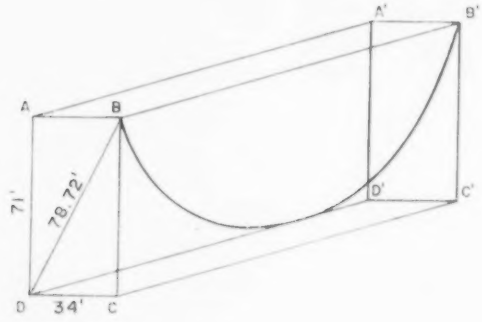


FIGURE 21

Find Radius:

$$R = \frac{4(78.72)^2 + (1000)^2}{8(78.72)}$$
$$= 1627.3 \text{ ft.}$$

Use 1627.3 to calculate bending stress:

$$S_b = \frac{E\,C}{R}$$

$E = 30{,}000{,}000$ psi

$$C = \frac{OD}{2} = 1 \text{ ft}$$

$R = 1627.3$ ft

$$S_b = \frac{30{,}000{,}000\ (1)}{1627.3}$$
$$= 18{,}435 \text{ psi}$$

Calculate current stress:

$$S_c = \frac{T}{A}$$

$T = 164{,}219$ lb

$A =$ Steel area $= 67.89$ sq in.

$$S_c = \frac{164{,}207}{67.89}$$
$$= 2419 \text{ psi}$$

Calculate longitudinal pressure stress:

$$S_{lp} = \frac{P\,A'}{A}$$

where

$P =$ line pressure $= 1000$ psi

$A' =$ flow area $= 384.5$ sq in.

$A =$ steel area $= 67.89$ sq in.

$$S_{lp} = \frac{1000\ (384.5)}{67.89}$$
$$= 5664 \text{ psi}$$

Total stresses:

$$\Sigma = S_b + S_c + S_{lp}$$
$$= 18{,}435 + 2419 + 5664$$
$$= 26{,}518 \text{ psi}$$

Percent of yield:

$$= \frac{26{,}518}{42{,}000}$$
$$= 63.1\%$$

Percent of ultimate:

$$= \frac{26{,}518}{60{,}000}$$
$$= 44.2\%$$

VISUAL CONTROL FOR LAYING CATENARY

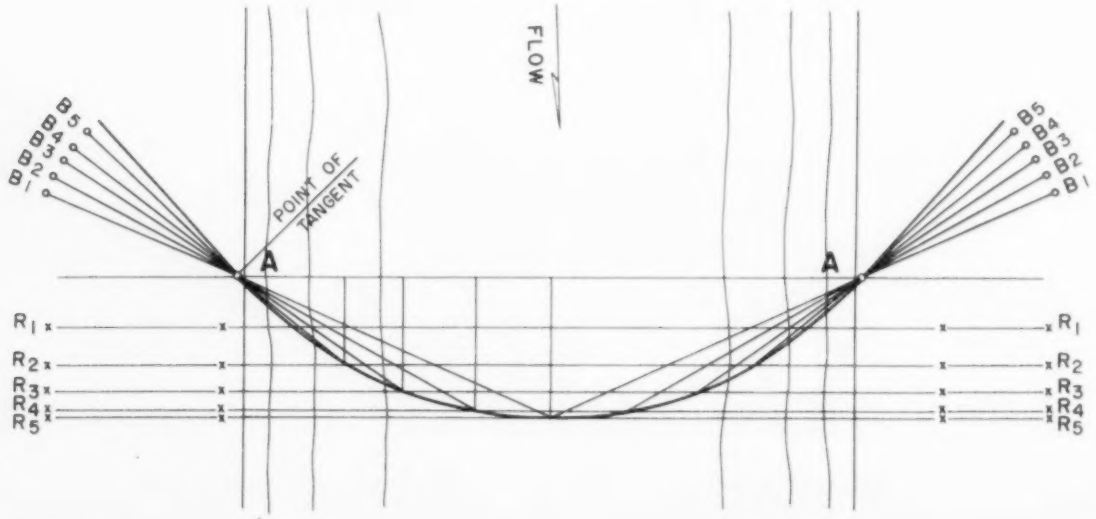
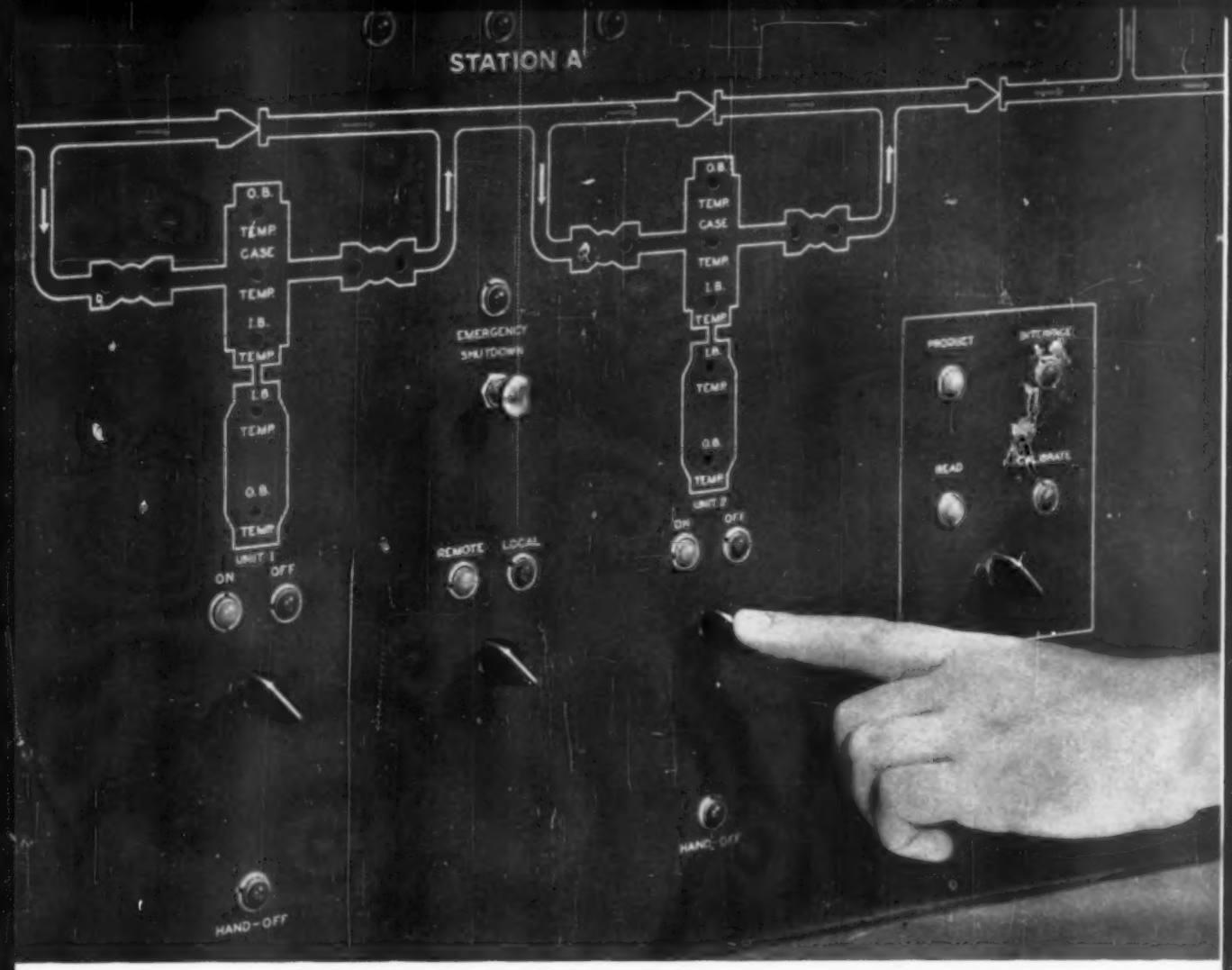


FIGURE 22



How to push a million gallons of oil from Texas to Chicago—*with one finger!*

A DISPATCHER, sitting at a control console in a central dispatching office, pushes a button—and Centralized Transport Control by Union Switch & Signal does the rest. Hundreds of miles away, a remotely controlled pump hums into action, giving the flowing oil the boost it needs. This is but one of many pumps, located in stations along the entire length of the pipeline, which are all controlled from the console.

On the control console, lighted diagrams tell the dispatcher exactly what is taking place at each pumping station along the line—which pumps are on the line, which valves are open. He can also obtain the temperature and pressures of the moving oil.

The dispatcher receives up-to-the-minute information constantly and automatically. He knows at all times what is happening throughout the entire system. He has fingertip control of all the pumps and valves that enable him to deliver oil at its destination in the most efficient and economical manner.

In the field of push-button science, Union Switch & Signal's record of achievement has been outstanding. In addition to control and communications equipment for pipelines, railways, subways, steel mills, and the mining industry, we have also designed and constructed electronic flight simulators, missile launchers, and air traffic control equipment.

We would welcome the opportunity to put our engineering knowledge and complete manufacturing facilities to work for you.

GENERAL APPARATUS SALES

UNION SWITCH & SIGNAL

DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY

PITTSBURGH 18, PENNSYLVANIA

OFFSHORE

PICTORIAL

1 On land or sea, pipe isn't a pipeline until it is welded.

2 The welded area is buffed clean before wrapping.

Bringing OIL

6 Pipe is pulled off the barge and along the outlined sea path by a tug.

7 A wave of the flag tells the tug to pull another completed joint.

8 Streams of water are jetted under the pipe to bury it. This man on the burying barge uses a long pole to feel for the pipe and keep the barge directly over it.

SCARCELY more than 10 years ago, offshore drilling was little more than a dream. Today, for the CATC group (Cities Service-Atlantic-Tidewater-Continental) it's a multimillion dollar reality.

Most of the 10 years that the new oil frontier has been opened, pioneer oil men have been exploring the unknown depths below the briny deep by seismic exploration and by drilling.

Cost of offshore exploration and development has been great but, success-wise, CATC has set an almost fantastic record — better than two discoveries out of every three wildcats drilled.

Bringing oil ashore is a problem of offshore drilling. Even the most land-locked oil man knows that a pipeline gathering system centrally located and serving a group of wells is the most efficient and economic way of collecting production. The same would be true offshore if it were no more trouble to lay a gathering line at sea than ashore.

Sea-going pipeliners do all their work from a specially built barge. The barge is anchored on location and as the coated pipe is welded and checked, it is pulled off the barge and along the outlined sea path by a tug.

The completed gathering system connects to a tank battery. These batteries, though quite different in looks, operate like those ashore.

Offshore pipelining is a relatively new venture and consequently only a relatively small portion of the wells are connected to a gathering system.

CATC group has an interest in 25 oil and 40 gas wells. Fifteen wells are being drilled and 50 more are slated for drilling this year.

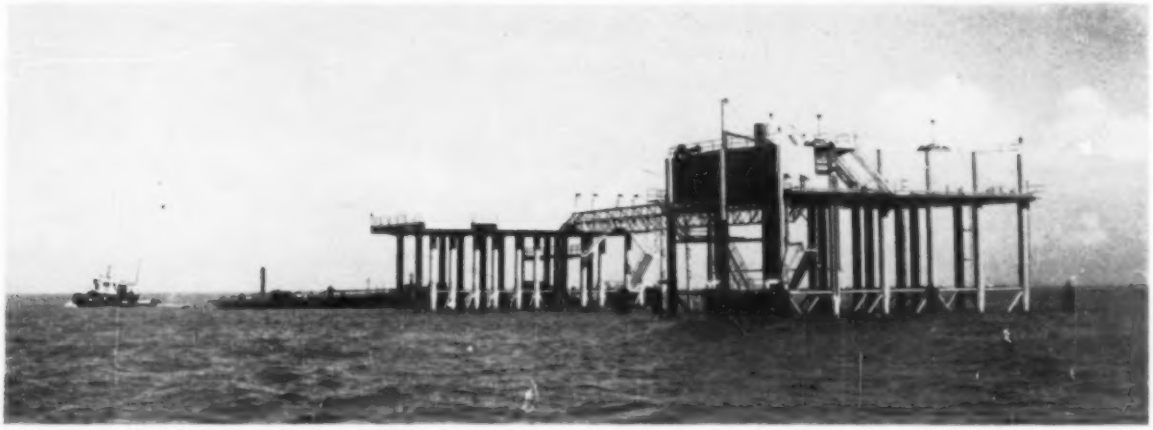
Photos and text are by courtesy of Cities Service Oil Company.

3 A special asphaltic wrapping makes the area water-tight. Heater insures seal.

4 Entire length of pipe is checked for coating faults with a holiday detector.

5 Faulty coating spots are peeled away and recoated. Pipe is now ready to leave the barge.

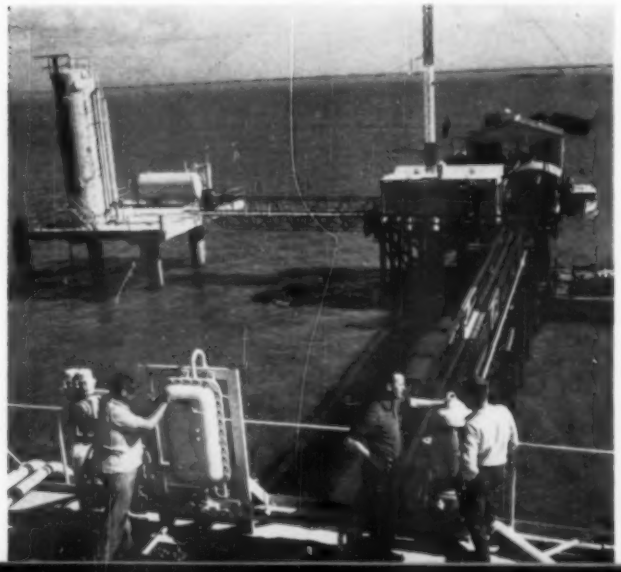
Ashore

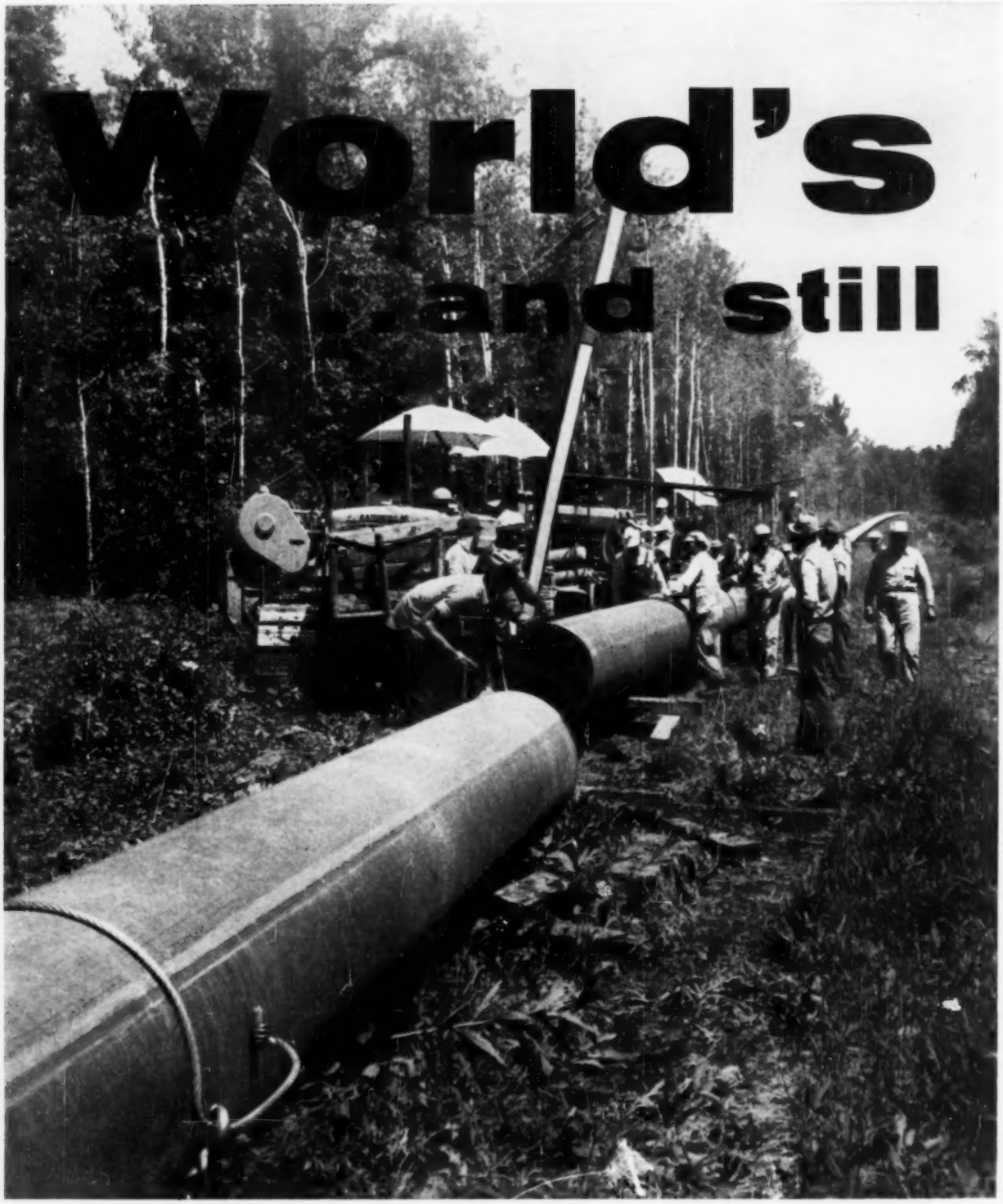


9 Natural gas and condensate wells that have been shut-in are now being connected into a gas transmission system. This unit is a connecting link between the CATC-owned gas gathering system in the West Delta area and gas purchaser's tansmission lines.

10 Installation for crude oil is similar in appearance to the gas and condensate unit. This picture was taken from the tank battery shown in succeeding photo.

11 Tank battery for storage of crude oil. Walkways connect the battery proper with the dog house and pump house. Crude treating units are atop storage tanks.





Interprovincial has extended their system from Superior to Sarnia and now from Sarnia to Port Credit, Ontario by the end of this year. It will then include over 3,000 miles of main line and loops. A. O. Smith's contribution to the system will be just above 50% of the total line laid.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

longest growing!

Interprovincial Pipe Line Company has 1,774 miles of main line now in service . . . will extend this system another 156 miles during '57

THIS is the big crude oil carrier from Edmonton, Alberta, to refineries in the Prairie Provinces and Ontario in Canada . . . Minnesota, Wisconsin and Michigan in the U. S. Spanning 1,774 miles, it's already the world's longest line of this type and construction is now under way that will increase main line length to over 1,900 miles.

A. O. Smith is proud to have been a part of this great system since the original main line of 1129 miles was constructed in 1950. Over 70% of this original line to Superior, Wisconsin was supplied by A. O. Smith. Since that time from both Milwaukee and Houston mills, A. O. Smith has supplied most of the pipe for the looping work done on this original section in 1953, 1954, 1956 and 1957.

Map shows the complete system of main and looping lines as it will be when this year's construction is completed.

On the current project, A. O. Smith is supplying pipe for the looping lines being built near Glenavon and between Clearbrook and Superior.

For almost 30 years...

A. O. Smith line pipe has always been manufactured to a high standard of quality . . . precisely-controlled at every step of production. That's why A. O. Smith pipe, made and installed in 1928, is still in operation. That's why so much A. O. Smith pipe is in nearly every important high-pressure line.

Through research A.O. Smith *. . . a better way*

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One Ditch, Four Pipelines, Five Products

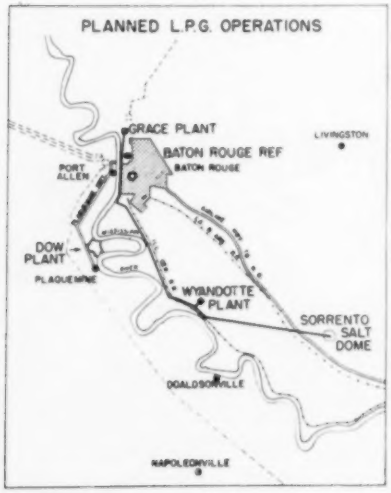
. . . that's the story of Interstate Oil Pipe Line Company's entry into the business of products pipelining; many innovations have gone into construction of the unique system

Frank H. Love, *Editor*

Half-track dolly was used to accommodate pipe with barrels attached on long push-job. Here a 6-joint section has just been welded onto string and is being pushed ahead.

PIPELINES for transportation of liquefied petroleum gases are of comparatively recent origin and their number limited. Consequently, much is yet to be learned in the matter of their construction and operation. Some of the answers have been provided by the newest LPG system, that of Interstate Oil Pipe Line Company between Baton Rouge, Louisiana, and the Sorrento Salt Dome. The nature of this project necessitated a number of construction innovations.

Five products —butane, propane, propylene, ethylene, and isobutane — will be pumped from the Esso refinery at Baton Rouge to the salt dome, 38 miles southeast, where they will be injected into cavities for storage. Propane, used as fuel, will be stored during summer months when demand is lowest, and withdrawn during the winter when production finds it difficult to keep up with demand. Butane, isobutane, and propylene, will be stored and withdrawn as needed in the refinery. Ethylene, used principally by chemical plants as raw materials, will be withdrawn or injected as needed to balance supply and demand.



Map shows how Interstate's products lines system in Baton Rouge area will look when completed, except for line from the refinery to the Dow plant.

Instead of using a single line for all five products, which would present problems in scheduling and dispatching, four separate lines were laid; an 8-in. line for propylene, a 6-in. for ethylene, and two 4-in. lines for butane and propane. Isobutane will be pumped through the butane line when it is not being used for the latter product.

Esso has leased a 100-acre tract in Sorrento Salt Dome area where five storage cavities have been formed by leaching, or dissolving, the salt at the bottom of wells drilled into solid rock salt. Resulting brine is popped to surface and stored in an open earthern pit, which has a capacity of 1,100,000 bbl.

To recover the LPG products, brine will be allowed to flow by gravity back into the storage cavities. Brine is saved and used for this purpose because fresh water would produce a leaching action that would enlarge the size of the cavity.

Top of the salt dome is approximately 2000 ft below the surface of the ground. The cavities are about 1000 ft deep and 35 ft in diameter. Two of the storage cavities have capacities of 150,000 bbl each, one a capacity of 200,000 bbl, and two of 300,000 bbl, as follows:

Well-1—300,000 bbl	Ethylene
Well-2—300,000 bbl	Butane
Well-3—150,000 bbl	Isobutane
Well-4—150,000	Propane
Well-5—200,000 bbl	Propylene
TOTAL 1,100,000 bbl	

Construction Methods

Laying one line in one ditch is a simple matter. But Interstate decided, all things considered, it would be more economical to lay all four LPG lines in the same ditch. This caused a lot of head scratching at first, and, obviously, called for a change in some customary construction methods. Ditching, for example, and lowering-in, to name two.

Ever ingenious, the engineering department of Interstate and the contracting firm of Fowler and Tatom came up with the answers.

Final specifications called for a ditch with minimum width of 54 in. On his own initiative, the contractor actually made a 60-in. ditch so he could do a better spacing job. Because of congested rights-of-way and soil conditions, conventional ditching machines could not be used to cut a ditch. Backhoes and clamshells were the answer and they worked perfectly.

Pipe joints were lined up on skids and welded into sections, which were then cradled into the ditch.

This last operation again required a degree of ingenuity. Conventional booms on lowering-in tractors were too short to handle pipe that had to be placed in the ditch at a distance of some 6 or 7 ft. Therefore, normal 16 and 18-ft booms were extended to 23

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NOW...A BIG-INCH

520 TRENCHLINER®

Here's the Big-Inch 520 in action on a 650-mile, 30-inch pipeline in the natural gas fields of Northwest Canada. Experience on isolated, cross-country jobs like this has proved the 520's performance under toughest conditions of materials and terrain.

Rounding out a complete line of wheel-type Trenchliners, Parsons also builds this smaller, heavy-duty 150. It has maximum 5¾ foot depth, 16 to 26-inch cutting widths, and speeds up to 25 feet per minute. Hydraulic wheel-hoist gives infinite depth adjustments, holds accurate grade. Ladder-type Trenchliners are also available on rubber or crawlers, in many sizes, to serve all your needs.

BIG THINGS HAVE HAPPENED since you last looked at big, wheel-type ditchers. New sizes have been added to Parsons line. First, meet the Big-Inch 520 Trenchliner — shown above. This wheel-type 520 digs 8½ feet deep, 40 to 52 inches wide — opens cross-country lines at speeds up to 28 lineal feet of trench per minute. And that's not all —

Also, a MIDDLE-INCH 420

Another big-wheel machine has joined the Trenchliner team — a Middle-Inch 420. It gives you digging depths to 7½ feet. Trench widths range from 31 to 46 inches. Depending on depths, widths, and job conditions, the 420 Trenchliner digs up to 44 lineal feet per minute.

Both of these big, wheel-type Inchers have been thoroughly job-proved. They were originally developed by C-R-C, and now built by Parsons — bringing you the *combined* engineering know-how and services of both firms. Call us next time you're in the market for a big ditcher.

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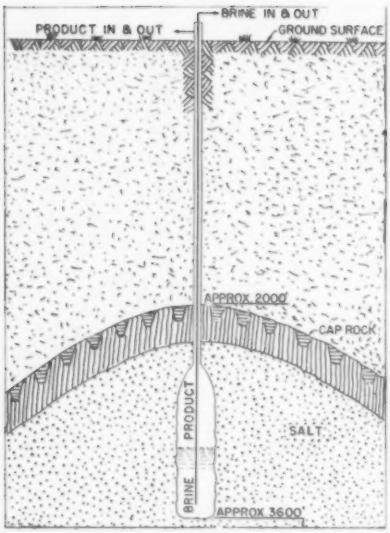
TRENCHLINERS for PIPELINERS



Rough cutaway sketch shows one of the smaller of the five salt-dome storage caverns being prepared at Sorrento. As illustrated, this one will measure about 850 ft in depth, with a diameter of about 35 ft, and a capacity of 150,000 bbl. When refinery pressure is down, brine enters closed piping system, forcing product out.

and 25 ft by welding in an additional section.

Smoothness of the operation is indicated in accompanying photographs. Lowering one section at a time, the lines were spaced 10 in. apart, then given a 3 to 4-ft cover, depth of cover varying in accordance with requirements for certain areas.

This method of laying was followed for most of the line. On the end adjacent to Sorrento Salt Dome, however, swampy terrain made it necessary to use the "push" method for the last 9000 ft, which meant shoving 36,000 ft of pipe. A ditch 8 ft in width at the top and 6 ft at the bottom was dug with clamshells. Steel barrels were used to buoy the pipe, which was welded in sections and shoved by means of tractors and winch lines.

Route of Line

Although not long in linear distance, the pipeline encountered as many obstacles as most longer lines.

Consider the right-of-way as the line leaves its point of origin in Baton Rouge. Almost immediately, only 900 ft after it has left the corner of the Esso refinery yard, it crosses under the Illinois Central switching yard for a distance of 600 ft. Of this, 275 ft had to be cased as protection for the pipe against stress and protection to the railroad against possible leakage.

The line then runs along without difficulty behind the railroad and Mississippi River levee for about three miles, boring underneath the Baton Rouge ferry ramp without interrupting service; then its luck runs out. The builders, being unable to get right-of-way for a straight course, found it necessary to cross over the top of the levee.

For three-quarters of a mile the line runs between the toe of the levee and River Road, then re-crosses the levee, goes another mile and three-quarters and crosses the levee again. That is the last it sees of the levee, but after 2.8 miles it must cross under the Illinois Central again to get on the east side of that railroad. It follows the railroad for a distance of 18 miles, although not on the railroad's property, then cuts across country for approximately 12 miles to the Dome.

Extended booms on tractors were necessary to lower pipe into the extra-wide ditch.

Four lines in four casings at this highway crossing point.

Tie-in crew prepares to set block valves at location near road. Block valves to be installed at the raised point of ditch.

Tight line is essential, due to nature of products to be handled, and welding requirements were rigid.

Extra-wide trench needed to lay four lines in same ditch made it impossible to use conventional trenchers. Backhoes and clamshells, however, did a good job in cutting the wide ditch in fast time.

Pipe Procurement

Recapitulation of the sources of line pipe reads almost like a roll call of the United Nations. Some of it came from Germany, some from Belgium, France, United States, and Italy. This was a time of tight pipe supply, as it still is, and the urgent need for the line made it necessary to buy wherever possible. It also explains in part why there was an intermixture of so many grades of pipe. Grade X52 electric weld German pipe weighing 22.36 lb per ft, X52 electric weld U. S. pipe weighing 27.74 lb per ft, both 8-in.; Grade A seamless from Belgium 4½-in. OD @ 10.79; Grade B seamless and Grade B electric weld from U. S. mills 4½-in. OD @ 10.79; X42 seamless and Grade B seamless from Italy 6⅝-in. @ 18.97; Grade A seamless from France and Germany 4½-in. OD @ 10.79.

These many grades and weights of pipe were fitted judiciously into the system, however, to provide a first-class finished pipeline.

Pipe was yard coated at Harvey, Louisiana, and Longview, Texas, with 3/32-in. minimum thickness modified type coal tar enamel, and 20-mil glass fiber and 15-lb perforated felt wraps applied.

Crossings were made of 6 railroads, 16 highways and roads, 9 bayous, one ferry ramp, and one canal. Railroad and road crossings were cased and vented. Bayous, which ranged from 45 to 302 ft in width and averaged 143 ft, were ditched with backhoes and the pipe was walked in.

Block valves have been installed approximately every seven miles, or at five locations, one valve on each of the four lines. The first four valves, six miles from the refinery, are pressure controlled; the others are operated manually. At all block valve locations lines are spaced 3 ft apart, which will provide ample room should it ever be decided to provide automatic controls.

Testing the Line

The nature of the products to be transported made it imperative to have a tight line. Welding requirements and testing specifications were strict. Welds on the first nine miles were X-rayed 100 percent for several reasons:

1. Nearness to the refinery,
2. Numerous crossings under railroad and levee, and
3. Because a part of the line was in the corporate limits of Baton Rouge.

Also 100 percent X-rayed were all tie-in welds at railroad, ferry ramp, road, highway, and bayou crossings. The rest of the line was X-rayed 50 percent.

The line itself was tested in three-mile sections. Pigs first were forced through the line by air, then 100-psi air pressure applied for a period of 24 hours. When the line was completed a hydrostatic test was given. To the 4 and 6-in. lines a pressure of 2200 psi was applied for a minimum of 12 hours. The 8-in. line was tested at 1800 psi for a like period of time.

The lines are designed for an operating pressure of 1500 to 1800 psi.

Pumps and Compressors

All products will be pumped from the Esso refinery at Baton Rouge to the salt dome. Because of the nature of the products to be handled and pressures involved, equipment selection was meticulous.

Here's how the products will be pumped:

Butane and propane. Both of these products will be pumped using vertical centrifugal multi-stage deep-well type pumps. The pumps will be driven by 250-hp electric motors. The pump handling butane is rated at 9000 gph at 60 F and 760 mm. The pump handling propane is rated at 7800 gph at 60 F and 760 mm. Specific gravity of the butane to be handled is .58 and for the propane, .51 specific gravity. Suction pressure on the butane pump is 100 psig and discharge pressure is 1560 psig. Suction pressure on the propane pump is 150 psig and discharge pressure is 1440 psig.

Four-inch pipe on this push job was "limber" and couldn't be pushed fast. Engineer with flag and field glasses works with engineer at walkie-talkie set to maintain communications with other segments of push crew. Man with field glasses checked alignment of pipe during push. Approximately 8000-ft of pipe was pushed east from this location to the dome.

Propylene. To handle the propylene, a multi-stage, horizontal centrifugal pump — with a horizontal centrifugal booster — will be used, powered by an 80-hp electric motor. This unit will handle a rated 27,700 gph at 60 F and 760 mm. The propylene has a specific gravity of .49. Suction pressure is 125 psig and discharge pressure is 1700 psig.

Ethylene. Two electric motor driven compressors will be used to handle the ethylene. Each compressor is of the two-stage reciprocating type, operating at 600 rpm. Motor horsepower is 350. Suction pressure is 271 psia and discharge pressure is 1581 psia at 2570 standard cu ft per min. ★ ★ ★

WITH THE PIPELINE CONTRACTORS

● **Houston Contracting Company, 2707 Ferndale Place, Houston 6, Texas.** Has 121 miles of 30-in. natural gas line for *Texas Eastern Transmission Corporation* from a point near Angleton, Texas, east to a point near Vidor, Texas. Work is being handled by three spreads; pipe laying began between March 2 and March 15.

● **H. B. Zachry Company, Box 2570, San Antonio 6, Texas.** Has 330,000 ft of 4½-in. line for *Phillips Petroleum Company* between Coke County and Midland County, Texas. Has three spreads of 30-in. line and river crossings for *Texas Eastern Transmission Corporation*. One spread of 353,700 ft extends from the Rio Grande River to the King Ranch; another, 358,500 ft between Port Lavaca and Highway 35. The river crossings are on the Rio Grande between McAllen and Vidor, Texas.

● **Panama-Williams Corporation, 1418 Melrose Building, Houston, Texas.** Has 76 miles of 4 and 6-in. line for *Phillips Chemical Company* between Pasadena and Sweeny, Texas. Also has 46 miles of 10-in. LPG and natural gasoline line to lay for *Gulf Refining Company* between the company's Waddell plant in Crane County, Texas, to Midland. Contracts for the remainder of this 530-mile line, extending to Houston, are yet to be let.

● **Majestic Contractors Limited, 408 Royal Trust Building, Edmonton, Alberta.** Has gathering system to lay for *Westspur Pipeline* in the Midale, Saskatchewan, area. Has undetermined amount of city distribution system for *Consumer Gas Company* in Toronto. Has 85 miles of 30-in. line — Section 7 — of *Trans-Canada Pipe Line, Ltd.*, natural gas line. This spread, with pipe laying to begin probably in June, is east of Winnipeg through territory largely muskeg and solid igneous rock.

● **River Construction Corporation, Box 9217, Fort Worth, Texas.** Has 84 miles of 8 and 10-in. line from Richmond to Stockton, California, to lay this string for *Southern Pacific Pipe Lines, Inc.*

● **Canadian River Construction, 580 Hornby Street, Vancouver, British Columbia.** Has 150 miles of gathering lines in northern Alberta and British Columbia for *Westcoast Transmission Company, Ltd.*

● **Ted Price Construction Company, Electra, Texas.** Has 205 miles of 1 to 8-in. distribution system in Walla Walla, Washington, and Pendleton and Baker, Oregon for *Cascade Gas Company*.

● **Troth Construction Company, Box 592, Britton, Oklahoma.** Has contract for 160 miles of 2 and 8-in. lines for gas distribution to communities in the Aberdeen, South Dakota, area, for *Northern Natural Gas Company*.

● **Fulton Banister, Ltd., 625 Northern Hardware Building, Edmonton, Alberta.** Has 33 miles of 24-in. for *Interprovincial Pipe Line Company* between Peebles and Glenavon, Saskatchewan, to begin construction about June 1.

● **Engineers Limited Pipeline Company, 200 Bush Street, San Francisco, California.** Has line for *Pacific Gas & Electric Company* consisting of 37 miles of 20-in., 37 miles of 18-in., and 19 miles of 12-in. to lay from Beehive Bend field to Sacramento, California. Has joint venture with J. E. Young, Pipe Line Contractor, Inc., on two sections of *Southern Pacific Pipe Lines, Inc.*, new products line. Contract involves 184 miles of 6 and 8-in. line between Roseville, California, and Fallon, Nevada.

● **Mannix, Ltd., 322 Seventh Avenue W., Calgary, Alberta.** Has 100 miles of 3 to 12-in. gathering line in the Pembina field to lay for *Pembina Pipeline Company, Ltd.* Has 110 miles of 30-in. for *Westcoast Transmission Company, Ltd.*, between Huntingdon and Kingsvalle, British Columbia. Has 90 miles of 34-in. to lay for *Trans-Canada Pipe Line Company* between Moose Jaw and Candiac, Saskatchewan. Has contract to lay 32 miles of 16-in. loop for *Pembina Pipe Line Company, Ltd.*, between Edmonton and Calmar, Alberta. Work on this project is to begin May 1.

● **Collins Construction Company, P. O. Box 86, Port Lavaca, Texas.** Has contract for laying 37,000 ft of 22-in. pipe for the *City of Los Angeles*, California. Line will serve as ocean outfall for sludge from Hyperion Treatment Plant at El Segundo, and will extend from El Segundo beach to a depth of 300 ft in the Pacific Ocean. Also has 11,000 ft of 4-in. pipe to lay for *Pan American Petroleum Corporation* from McFaddin Beach Dome near High Island to a producing well offshore in the Gulf of Mexico.

● **A. J. Curtis & Company, P. O. Box 1072, Casper, Wyoming.** Has undetermined amount of ¾ to 6-in. city distribution line to lay for *Spokane Natural Gas Company*.

● **Engineering-Construction Company, First National Bank Building, Tulsa, Oklahoma.** Has contract with *Northwestern Public Service Company* to lay distribution systems in four towns in South Dakota, also has extensions in another South Dakota town. Field office has been set up in DeSmet; work started April 15.

● **American Pipe Coating Contractors, Inc., P. O. Box 89, Jennings, Louisiana.** Has 47½ miles of 3-in. line for *Magnolia Petroleum Company*. Has 6 miles of 4-in. for *Bell Oil Company*. Has 10½ miles of 12-in. line for *Gulf Interstate Gas Company*. Also has 17 miles of 12 and 16-in. gathering system for Anchor-Wate, Inc., (for *American Louisiana Pipe Line Company*).

● **Dunn Bros., Inc., 801 Mercantile Securities Building, P. O. Box 5771, Dallas, Texas.** Has 105 miles of 34-in. for *El Paso Natural Gas Company* between St. Michaels and Navajo Station, Arizona. Has 145 miles of 34-in. line for *Western Pipe Line Company* east of Flagstaff to Topock, Arizona.

● **O. R. Burden Construction Corporation, P. O. Box 5216, Tulsa, Oklahoma.** Has 8 miles of 20-in. to take up in the vicinity of Roland, Arkansas, for *Magnolia Pipeline Company*. Has completed laying a similar amount of new line paralleling take-up job. Has contract for 185 miles of 20-in. crude line for the *Tecumseh Pipe Line Company* to extend from Scherville, Indiana, to Cygnet, Ohio. Has contract for 44 miles of 24-in. line between Sugar Grove and Homer, Ohio, for the *Ohio Fuel Gas Company-Columbia Gas System*. Has been awarded contract to lay 120 miles of 16-in. and 4 miles of 12-in. crude line for *Magnolia Pipe Line Company* between Abilene and Midland, Texas; this project will not begin till late summer.

● **R. H. Fulton & Company, Inc., P. O. Box 1526, Lubbock, Texas.** Has 252 miles of 22-in. line for *Colorado Interstate Gas Company* between Rock Springs and Laramie, Wyoming. Has 78.4 miles of 26-in. line in the Minnesota section of *Interprovincial Pipe Line Company's* main line loop.

● **Somerville Construction Company, Ada, Michigan.** Has 67 miles of 10 and 12-in. line from Clare County to Traverse City, Michigan, for *Michigan Consolidated Gas Company*. Also has 60 miles of 10 and 12-in. line between Muskegon and Ludington, Michigan, for the same company.

● **Williams Brothers Company, National Bank of Tulsa Bldg., Tulsa, Oklahoma.** Has 212.5 mile 20-in. crude line for *Socony Mobil Oil Company de Venezuela*. Line will extend from San Silvestre field to Puerto Cabello on the Caribbean Coast.

● **H. C. Price Company, Box 1111, Bartlesville, Oklahoma.** Has 71 miles of 30-in. line for *Texas Eastern Transmission Corporation* in the Port Lavaca, Texas, area.

● **Trojan Construction Company, Inc., 1416 N. Robinson, Oklahoma City 3, Oklahoma.** Has contract for takeup and reconditioning 276 miles of 8-in. line for *Sinclair Pipe Line Company* between Jacksboro and Mexia, Texas.

● **Eastern Pipeline Contractors, Mercantile Bank Bldg., Dallas, Texas.** Has contract for 89 miles of 6 and 8-in. line for *Gulf Refining Company*, from a point westward from Midland into New Mexico, near Hobbs.

● **Price-Poole Pipeline Constructors of Canada (joint venture of H. C. Price of Canada Limited and Poole Construction Company, Ltd., Rivers, Manitoba.** Has 99-mile section of 34-in. pipe to lay for *Trans-Canada Pipe Line Company* on a section of line in Manitoba Province extending eastward from the Assiniboine River near Miniota. Right of way has been cleared and limited activity is underway prior to actual construction beginning this spring as weather permits.

● **Hood Construction Company, 3002 E. Century Blvd., Lynwood, California.** Has 81 miles of 10-in. line for *Southern Pacific Pipe Lines, Inc.*, beginning west of Lodi and running to a point near Roseville, California; this is second section of firm's 323 mile products line.

● **J. E. Young, Pipe Line Contractor, Inc., 931 E. Rosecrans Avenue, Los Angeles, California.** Has joint venture with Engineers Limited on two sections of the 323 mile *Southern Pacific Pipe Lines, Inc.*, new products line. Contract includes 184 miles of 6 and 8-in. line extending from Roseville, California, to Fallon, Nevada.

● **Dutton-Williams Bros., Ltd., North Canadian Oils Building, Calgary, Alberta.** Has approximately 320 miles of distribution and transmission systems for *Inland Natural Gas Company* in and connecting several British Columbia towns. Project includes 154.5 miles of 12 in. line, 110 miles of 10 in., and remainder from 8 to ¾-in. in Nelson, Savona, Penticton, Castlegar, Kelowna, Kamloops, and Grand Forks. Also has contract for 47.5 miles of 12-in. oil line from Gilbey to Sundre for *Rangeland Pipe Line Company*. Has contract for testing 310 miles of *Westcoast Transmission, Ltd.*, 30-in. line from Taylor, B. C., to M. P. 310; completion is expected in September. Has contract for 50.8 miles of 30-in. oil line for *Trans Mountain Oil Pipe Line Company* between Edson and Minton, Alberta.

● **Banister Construction, Ltd., 625 Northern Hardware Bldg., Edmonton, Alberta.** Has undetermined amount of 2 to 6-in. extensions to existing systems in cities and towns in Saskatchewan, plus approximately 5000 consumer service connections, for *Saskatchewan Power Corporation*. Also has contract for 16 miles of 10-in. line from the Trans-Canada pipeline to the City of Brandon, Manitoba, for *Plains-Western Gas & Electric Company;* this project includes installation of approximately 3000 consumer service connections.

● **C. P. Bartley & Son Pipe Line Construction, 616 Welo Street, Tioga, North Dakota.** Has 110 miles of 3 through 12-in. gas gathering extensions for *Signal Oil & Gas Company* in the Newton, North Dakota, area.

● **Sheehan Pipe Line Construction Company, National Bank of Tulsa Bldg., Tulsa, Oklahoma.** Has 116 miles of 8-in. line for *Buckeye Pipe Line Company* between Huntington and Griffith, Indiana; project includes take-up, reconditioning and relay.

● **Sheehan Constructors of Canada, Ltd., Toronto, Ontario.** Has joint venture with Robert B. Somerville Company, Ltd. for 91 miles of 20-in. line between Bright and Sarnia, Ontario, for *Interprovincial Pipe Line Company*.

● **Mid-States Construction Company, P. O. Box 417, Mt. Vernon, Illinois.** Has approximately 25 miles of ¾ to 8-in. line for *Missouri Natural Gas Company* from the junction of Mississippi River Fuel main line to and including distribution mains and services in the towns of Pevely, Herculaneum, and Hematite, Missouri.

● **Robert B. Somerville Company, Ltd., 4891 Yonge Street, Toronto, Ontario.** Has joint venture with Sheehan Constructors for 91 miles of 20-in. line between Sarnia and Bright, Ontario, for *Interprovincial Pipe Line Company*. Job started May 13.

● **Williams-Austin Construction Corporation, 3322 Grant Building, Pittsburgh 19, Pennsylvania.** Has 187,000 ft of 10-in. for *Central Hudson Gas & Electric Company* between Kingston and Albany, New York.

● **Latex Construction Company of Georgia, Box 56, Northside Branch, Atlanta, Georgia.** Has contract, beginning June 15, for 46 miles of 24-in. line for *Michigan Wisconsin Pipe Line Company*. Line extends southwest from a point near Milwaukee, Wisconsin. Also contract from *City of Jacksonville, Florida*, for laying 6 miles of 6-in. oil static electric transmission conduit pipeline within the city of Jacksonville. Also has 15 miles of 8-in. distribution service line for *South Atlantic Gas* in Savannah and Chatham counties, Georgia.

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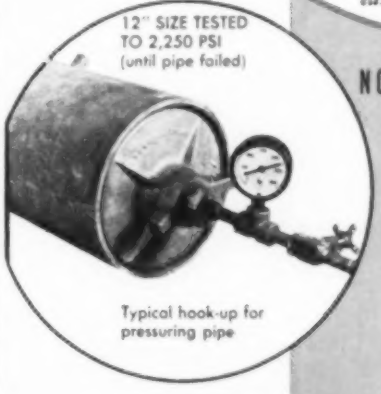

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Pipeline Projects

NGPL Seeks $180,000,000 Expansion

Natural Gas Pipeline Company of America has asked the Federal Power Commission in Washington for permission to increase its daily deliverability in addition to its current major expansion program.

The company, which delivers natural gas to utilities in six states, is seeking approval to increase facilities in order to provide 185,000,000 cu ft per day.

Construction work for the new expansion plan will include installation of 337 miles of 30-in. loop line between the company's terminus in Texas and Beatrice, Nebraska. Fifty-nine miles of 36-in. pipeline also will be laid between Beatrice and Joilet, Illinois.

At present the long-distance line operated by NGPL is made up of dual 24 and 26-in. lines. The two expansion plans would result in a parallel of all these lines with new large-diameter pipeline.

There will be 29,750 increased compressor engine horsepower in stations along the main line from Fritch to Joliet.

Total cost of the proposed expansion of NGPL and its affiliate, Texas Illinois Natural Gas Pipeline Company, is estimated at over $180,000,000.

The six states to which NGPL delivers natural gas to utilities are Kansas, Nebraska, Iowa, Indiana, Wisconsin, and Illinois.

Gulf Interstate to Boost Capacity 575,000,000 Cu Ft

Federal Power Commission has granted Gulf Interstate Gas Company temporary authorization to construct natural gas facilities at an estimated cost of about $24,500,000 which would boost its designed daily delivery capacity to 575,000,000 cu ft per day.

Gulf Interstate's existing service consists solely of the transportation of natural gas for United Fuel Gas Company, of Charleston, West Virginia, and delivery to United Fuel at Means and Leach, Kentucky.

Facilities include the addition of 69,000 hp in 10 existing main line compressor stations in Kentucky, Tennessee, Mississippi and Louisiana; a 300-hp compressor station at East Mud Lake field, Cameron Parish, Louisiana, and approximately 10 miles of gathering line from Erath field.

British Columbia Crude Oil Pipeline Proposed

Act Oils has applied to the British Columbia government for a permit to construct a crude oil pipeline from the Peace River area in northeastern British Columbia to tidewater at Bella Coola, about 350 miles north of Victoria.

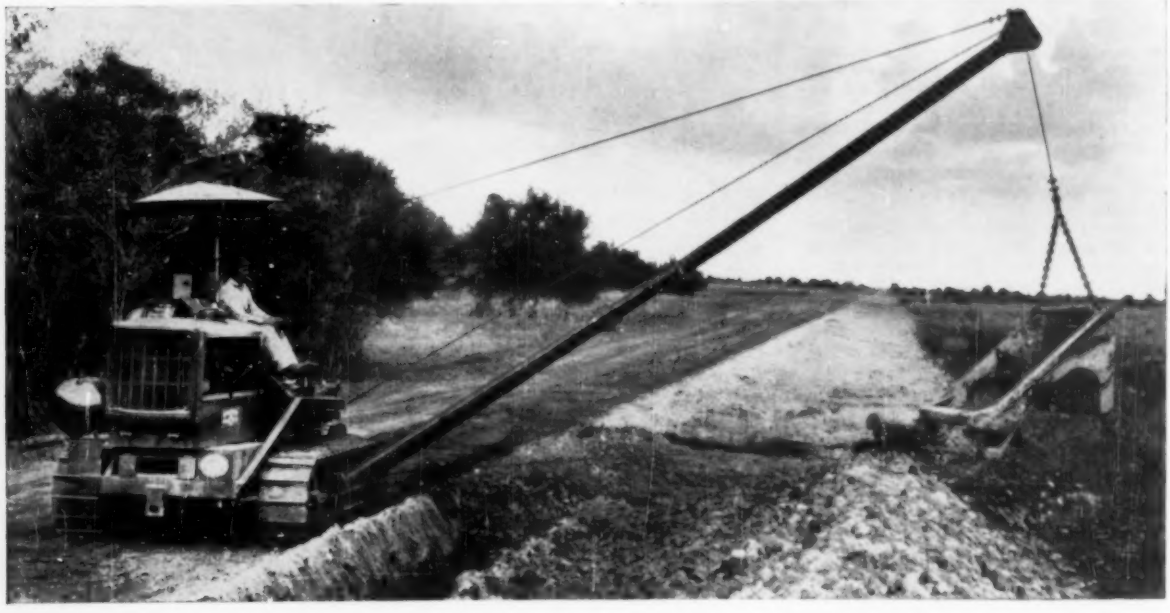
The line would extend from Peace River down the Pine Pass to Prince George, then directly west to the sea.

Those interested in the project are J. W. Buckley, Stamford, Connecticut; J. T. Sinclair, Houston, Texas; L. W. Storms, Houston; R. J. Richardson, Calgary, and J. L. Lewis, Toronto.

FPC Authorizes Line N.Y. State Natural

The Federal Power Commission has granted New York State Natural Gas Corporation, of Pittsburgh, Pennsylvania, temporary authorization to construct and operate 14.6 miles of natural gas pipeline and to operate 17 miles of constructed line in Pennsylvania and New York.

New York Natural proposes to replace its 56.5-mile, 20-in. No. 1 line extending from its Boom compressor station in Tioga County, Pennsylvania, to Ithaca, New York, with 30-in. line over a period of four years.



WORKING ON THE HEELS OF THE LOWER-IN CREW a one-man-operated Cleveland 190 helped to keep this United Gas pipeline job moving along, leaving no open trench at the end of any day's work: A report from Fowler-Tatom Pipeline Contractors states, "The Cleveland 190 backfilled trench almost as fast as a man can walk." Where trenches were water-filled the 190 tied down pipe then doubled back to complete the fill and finished it off with a neat clean-up job. Much of the 16-mile line from the Chocolate Bayou field to the main line near Webster, Texas, cuts through rice-growing farmlands, so the 190 had to pull down big heavy spoil banks of wet sticky gumbo much of the way.

THE CLEVELAND TRENCHER COMPANY, 20100 St. Clair Avenue, Cleveland 17, Ohio

Pacific Northwest Revises Requests to FPC

Pacific Northwest Pipeline Corporation of Salt Lake City, Utah, has supplemented two applications filed with the Federal Power Commission revising its proposed natural gas facilities to result in a reduction of approximately $17,000,000 in the estimated cost.

In Docket No. G-10,426, Pacific Northwest proposes to eliminate from its original application the proposed installation of an additional 4500 hp at its compressor station No. 6. As now proposed, the facilities would include 3320 additional hp in two existing stations and a sales meter station. Effect of the elimination reduces the cost of the proposed facilities from $3,149,540 to $1,132,100.

In Docket No. G-10,455, Pacific Northwest now seeks authorization to construct and operate 22,500 hp in existing stations in lieu of the initially proposed 55,500 hp in existing and new compressor stations. The company also proposes to install sales meter facilities in an existing compressor station and to enlarge its San Juan processing plant. Estimated cost of these facilities is about $9,158,850 compared with an estimated cost of approximately $24,267,545 for the construction originally proposed.

FPC Authorizes Ohio Fuel Gas Construction

The Federal Power Commission has temporarily authorized The Ohio Fuel Gas Company, Columbus, Ohio, to construct approximately 37.7 miles of 24-in. line looping its line running northward from its Crawford station in Fairfield County to Treat station in Licking County. Estimated cost of the proposed facilities is about $2,830,000. Ohio Fuel also was temporarily authorized to construct and operate a tie-in for the 24-in. line at the Crawford station at an estimated cost of $22,900.

NGPL to Supercharge 89 Compressor Engines

The Federal Power Commission has granted Natural Gas Pipeline Company of America temporary authorization to supercharge 86 main line compressor engines in its stations No. 102-110, in Oklahoma, Kansas, Nebraska, Iowa, and Illinois.

Eastern Shore Natural Plans 124-Mile Line

With the Federal Power Commission's permission Eastern Shore Natural Gas Company, Salisbury, Maryland, will construct approximately 124 miles of 6⅝-in. and 8⅝-in. transmission line and appurtenant facilities in Delaware and Maryland.

Cost is estimated at $3,025,000.

165-Mile Crude Oil Line for Michigan

A new crude oil pipeline to supply refineries at Muskegon, Michigan, will be completed late in 1957 by the newly organized Muskegon Pipe Line Corporation. The 165-mile, 10-in. line will extend from Griffith, Indiana, to Muskegon.

Max M. Fisher, chairman of the board of the Aurora Gasoline Company, said that the formation of the new company is a joint undertaking of Aurora and Service Pipe Line Company of Tulsa, Oklahoma.

Wm. E. Slaughter, Jr., president of Aurora Gasoline Company, is president of the new pipeline company. Other officers and directors are M. S. Schiller and Harris Squire, vice presidents; J. R. Fredenberger, secretary-treasurer, and C. W. Butler, director.

The line will supply Aurora Gasoline Company and the Naph-Sol Refining Company at Muskegon, and will have an initial capacity of about 26,000 bbl per day.

The general route of the line will follow the Lake Michigan eastern shore, but will be several miles inland. It will avoid major cities and congested areas where possible.

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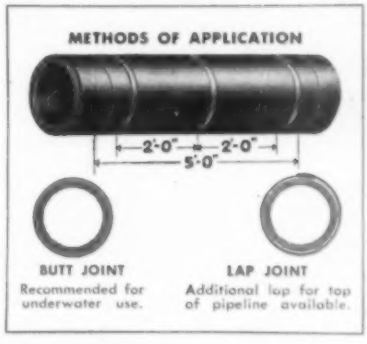

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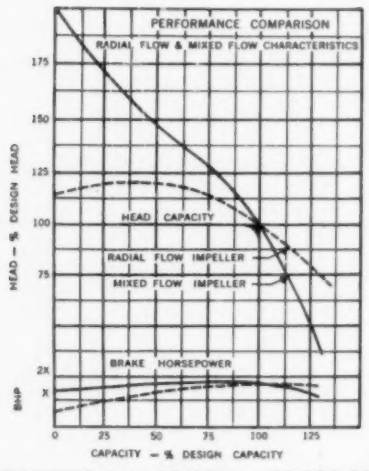

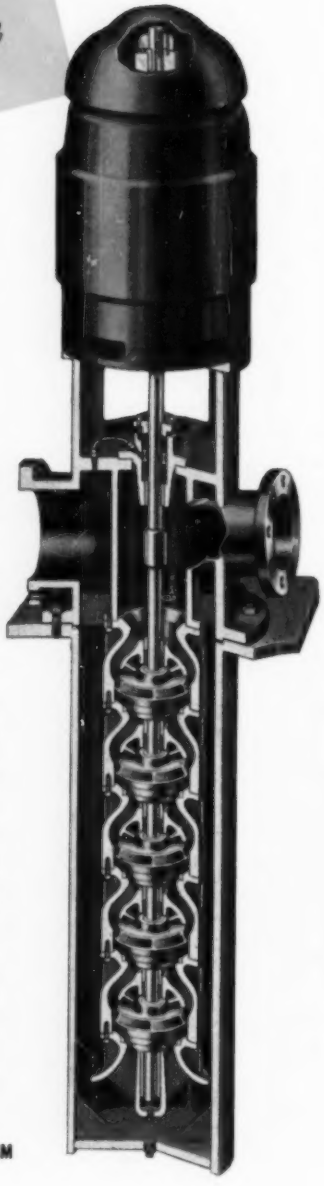

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Projects

Second Crude Oil Line Planned from Hugoton Area

A second crude oil line to serve the Hugoton field, Kansas, has been proposed by Musgrove Petroleum Company of Wichita, Kansas, and Panhandle Eastern Pipe Line Company, Kansas City.

The line would extend northeast from Hugoton to Raymond in Rice County, Kansas, where it would tie into the Arapahoe Pipe Line Company system. Arapahoe now moves oil from the Denver-Julesburg Basin through Kansas to Freeman, Missouri, where it connects with Service Pipe Line Company's system to Chicago.

Another outlet for Hugoton wells was announced recently by Anderson-Prichard Oil Corporation of Oklahoma City and Aladdin Petroleum Corporation. This line would extend from Hugoton to Arkansas City where Anderson-Pritchard has a refinery.

440-Mile Products Line Planned for Eastern U.S.

Laurel Pipe Line Company has been formed to build and operate a products line that will extend 440 miles from Philadelphia to Pittsburgh to Cleveland. Gulf Oil Corporation has a 40 percent interest, Sinclair Pipe Line Company a 35 percent interest, and The Texas Company 25 percent.

The proposed pipeline's diameter will vary from 14 to 24 in., with more than 109 miles scheduled to consist of 24-in. diameter pipe. Estimated cost of the project is approximately $50,000,000.

Major construction of the line is expected to begin in 1958.

Plans call for the line to originate in the Philadelphia area. Refined products will be made available to consumers through numerous distribution points along the route of the line in Pennsylvania and Ohio.

Northern Natural to Connect Oklahoma Gas Supply

Colorado Interstate Gas Company, of Colorado Springs, Colorado, has been authorized by FPC to construct and operate 50 miles of 22-in. line in Oklahoma to enable it to receive into its system a newly acquired gas supply from the Mocane field area of Oklahoma.

The line, estimated to cost $2,424,441, will extend from Colorado Interstate's newly acquired gas supply in the Mocane field to a connection with the company's existing system at Hooker, Oklahoma.

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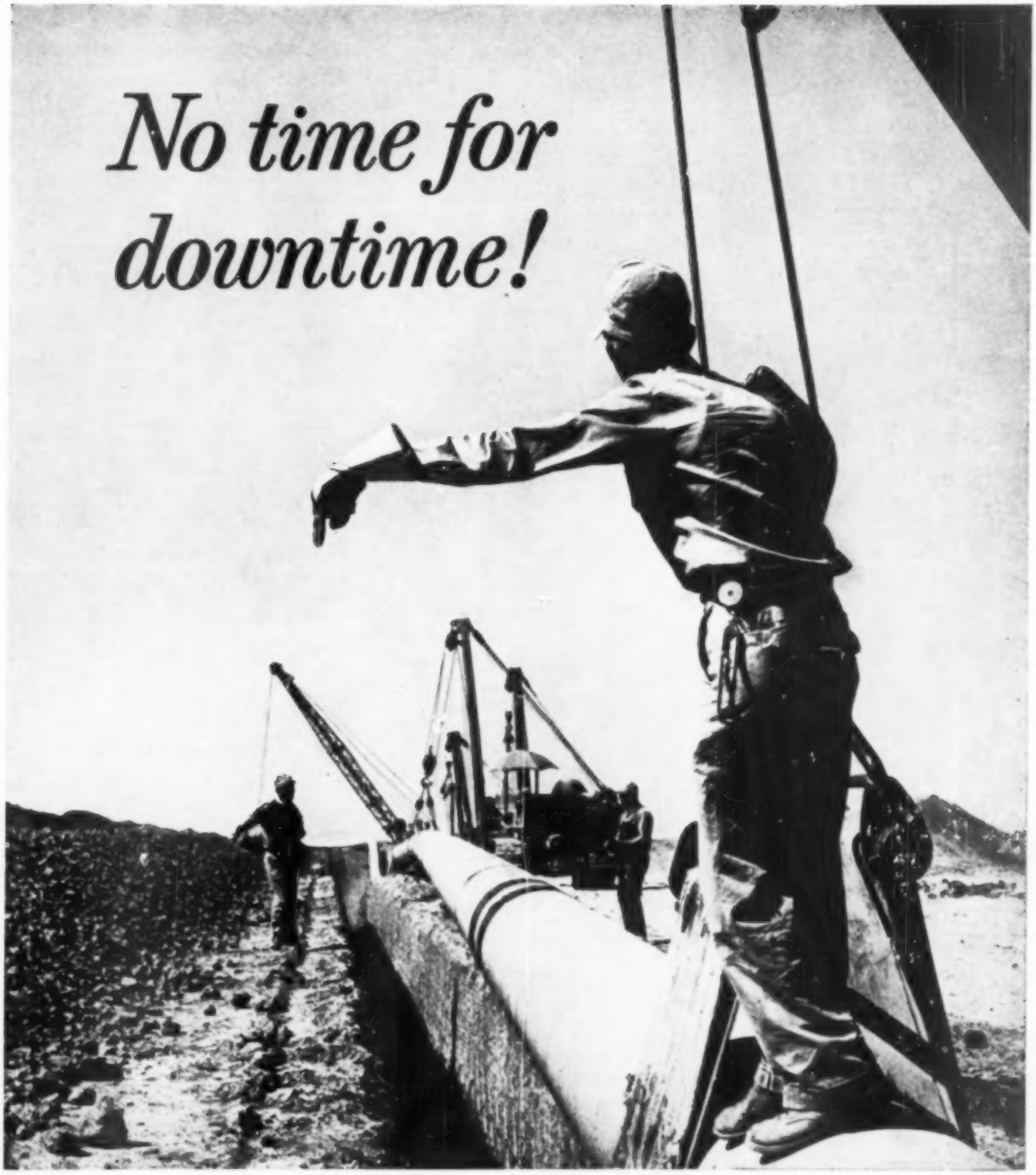

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Pipeline Personals

▸ **B. D. Leuty** has been elected president of Cities Service Pipe Line Company. He was serving as manager of pipeline transportation and vice president of Cities Service Pipe Line. Elected to serve with him are **Harry Nelson,** vice president and manager; **G. R. Preston,** vice president and treasurer; **G. C. Richardson** and **R. E. Roehl,** vice presidents, and **O. W. Bailey,** secretary.

▸ **N. John McNeill,** secretary of Trans-Canada Pipe Lines, Limited, has been appointed vice president and secretary and **Robert C. Berry,** treasurer, as vice president and treasurer. McNeill was resident partner in Calgary for the legal firm of Milner, Steer, Martland & McNeill. Berry was senior resident partner of the Montreal accountancy firm of Deloitte, Plender, Haskins & Sells before joining Trans-Canada as treasurer.

▸ **George T. Naff,** vice chairman of the board of Texas Eastern Transmission Corporation, has retired. Naff, who has been with the company since it was founded and served as president for almost three years, will serve as a consultant to Texas Eastern and others on oil and gas matters and engage in the private practice of law.

▸ **Don R. Shannon** has been appointed sales representative in Washington and Oregon by T.D. Williamson, Inc., Tulsa, Oklahoma, manufacturer of engineered piping equipment. His headquarters are in Seattle. Shannon is an engineering graduate of the University of Minnesota. He served in the Air Force during World War II and has a total of six years experience in maintenance control and engineering at Northwest Airlines & Boeing Aircraft Company. During a recent visit to Tulsa he completed the factory course on application, operation, and maintenance of Williamson equipment. Other manufacturers represented by Shannon include RCS Tool Corporation and Bett-Marr Sales, Inc.

Don R. Shannon

▸ **D. T. Lutz** has been named superintendent of compressor stations at Malvern, Arkansas, by the Texas Illinois Natural Gas Pipeline Company. He succeeds **H. D. Jacobsen,** who is leaving the company to take a job with Western Pipe Line, Inc., Austin, Texas. Lutz was superintendent of the Natural Gas Pipeline Company of America compressor station at Stinnett, Texas, prior to the appointment. NGPL is an affiliate of Texas Illinois.

▸ **W. K. Sanders** has been elected president of Trunkline Gas Company, Houston, Texas, a subsidiary of Panhandle Eastern Pipe Line Company. He was formerly vice president of Trunkline.

Glen F. Graves has been promoted to superintendent of the right-of-way department of Trunkline Gas.

▸ **Paul Kayser,** president of El Paso Natural Gas Company, has been elected chairman of the board of directors of Pacific Northwest Pipeline Corporation and an officer and director of several other companies in which Pacific Northwest has

Paul Kayser

Ray C. Fish

interests. He succeeds **Ray C. Fish,** who continues as a director of the corporation. Reflecting the recent acquisition of Pacific Northwest by El Paso Natural Gas Company, a number of other changes in management and boards of directors of Pacific Northwest and subsidiary and affiliated companies were announced. **Howard Boyd,** vice president and assistant general counsel of El Paso Natural Gas Company, has been elected vice chairman of the Pacific Northwest board, succeeding **C. R. Williams,** who remains a member of the board of directors.

Election of Kayser and Boyd to board membership followed the resignations of **Robert R. Herring** and **Norman V. Kinsey. Stuart F. Silloway** continues as president of Pacific Northwest.

Kayser also was elected chairman of the board of Northwest Production Corporation (67 percent of common stock owned by Pacific Northwest), and president of Westcoast Investment Corporation (wholly-owned by Pacific Northwest).

C. L. Perkins, vice president of El Paso Natural Gas Company and president of El Paso Natural Gas Products Company, was elected president of Northwest Production Corporation.

Donald L. Anderson, has been named to the newly created position of supervisor of gas purchases for Pacific Northwest Pipeline. He was district manager of the Pacific land department prior to his promotion.

Jack B. Owens has been named controller of Pacific Northwest Pipeline. Owens, who has been assistant controller, fills the vacancy created by the resignation of **G. Byron Smith.**

▸ **A. L. Williams** has been named manager of the stores department for Lone Star Gas Company and its wholly owned subsidiary, Lone Star Producing Company. Named as his assistant is **Fred E. Bethurum.** Williams, the former assistant manager, succeeds **E. L. Harpold** who retired March 31.

Walter J. Roberge has been named manager of the purchasing department for Lone Star Gas and Lone Star Producing. Former assistant manager, he succeeds **W. G. Nash** who has retired.

▸ **R. R. McDaniel,** field superintendent for Southern Pacific Pipe Lines' northern district, now has his headquarters at Roseville, California. He has been stationed at San Francisco. **R. J. Potthast** has been appointed chief operator-deliveryman at Watson, California.

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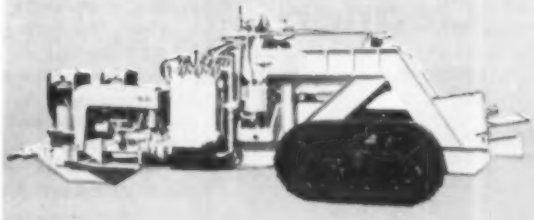

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Canadian News Notes

Northern Ontario gas line. Pipe specifications have been released by Northern Ontario Pipe Line Crown Corporation for its 30-in. gas line across northwestern Ontario between the two main portions of the Trans-Canadian Pipe Lines, Ltd., system from Alberta fields to southern Ontario.

The 310.7 miles to be laid this season, between the Manitoba-Ontario border and a point a short distance north of Port Arthur, Ontario, on Lake Superior, will be 30-in. OD, ⅜-in. wall thickness, electric weld, API 5L X Grade X 52.

The northern Ontario line has been divided into four spreads for 1957 construction. Spread A runs from milepost zero at the Manitoba-Ontario boundary to MP 57.7, at the point where the right-of-way first crosses Ontario No. 17 highway east of Kenora, a distance of 57.7 miles, of which a large proportion is alternate igneous rock and deep muskeg or swamp. Spread B starts at MP 57.7 and terminates at MP 151.8, a distance of 94.1 miles, the longest of the four spreads. It ends at a point on the line between Hyndman and Hodgson townships, approximately half way between Dryden and Ignace, Ontario. Spread C runs between MP 151.8 and MP 232.2, covering 80.4 miles and terminating at a point in Stedman township near the village of Upsala. Spread D contains 78.5 miles, starting at MP 232.2 and terminating at MP 310.7 in Gorham township, a few miles north of Port Arthur and Fort William.

The 1957 construction schedule comprises about half the mileage that will be constructed by the Crown corporation. The corporation is a dominion government body, in which the Ontario provincial government has a right of participation but is not obligated to share in the cost until after the line is built. The line is under lease-option to Trans-Canada, which may purchase it at any time on payment of the cost plus a fixed return of 3½ percent net interest over the period between completion of construction and time of exercising the option.

Bellshill Lake line. One of the smaller crude oil pipelines in Alberta will serve the Bellshill Lake field of the central plains area. Line will be owned and operated by Gibson Crude Oil Purchasing Company, Ltd., of Calgary, one of the more active independent crude oil buyers, which has a large share of crude oil purchases from the more remote fields and those that are not served by pipeline connections. Gibson will operate a short line consisting of 19.25 miles of 6-in. main line and 3 miles of laterals for the gathering system.

Trans-Mountain. Throughput for Trans-Mountain Oil Pipe Line Company in the first quarter of 1957 set a new high mark of 186,184 bbl per day average, up more than 50 percent over the first quarter of 1956 when it carried 122,959 bbl per day average. Trans-Mountain has already announced its 1957 looping program, which involves 50 miles of 30-in. line near the eastern boundary of Jasper National Park. Dutton-Williams Brothers, Ltd., expects to start laying pipe within a few weeks on this contract, which is scheduled for completion before August 1.

Alberta gas trunk line. Fulton Banister, Ltd., of Edmonton has been awarded the construction contractor for the first stage of the Alberta Gas Trunk Line Company, Ltd.'s gathering system for natural gas going into the Trans-Canada pipeline. The 1957 program is a very modest one, involving the laying of only about 35 miles of line. The Fulton Banister contract includes 15.9 miles of 34-in. main line connecting the Bindloss gas field with the provincial gate at Burstall where the main Trans-Canada line takes off. It also includes 19 miles of 18-in. line connecting the Sibbald gas field with the Bindloss junction point.

NOTICE: No change except the corporate name. We still have the same ownership, same management, same address, same telephone, and use the same 45 years of experience to render the same service under the same trade name—"PELCO."

Specify **PELCO** Welding Saddles

PELICAN SUPPLY CO. INC.

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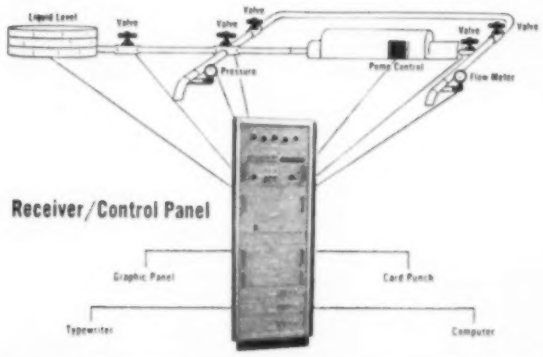
SEE YOUR NEAREST SUPPLY HOUSE

(Formerly: Pelican Well Tool & Supply Company)

Automatic Monitoring and Control of ANY Remote Pipeline Operation



with

Bendix-Pacific ELECTRO-SPAN

THE LOW COST DIGITAL SYSTEM

Electro-Span Systems are accurate, reliable digital data transmission systems for pipeline telemetering and supervisory control.

Any number of remote pump stations or functions can be controlled from one or more control locations with these Bendix engineered systems.

The functions of control, indication, data-logging, and monitoring can be provided singly or in combination, providing the most accurate, efficient and inexpensive use of standard communication links.

Write for the new brochure which fully describes these pipeline supervisory control and data-logging systems. Please request Bulletin ES-12.

VERSATILE TANK GAUGING SYSTEMS

Any number of tanks can be measured and controlled by the Bendix digital pulse-code system. The receiving equipment can indicate tank liquid level in feet, inches and eighths as well as temperature by tank number and can scan several tank farms automatically. Write for Bulletin ES-5A for full information.

Department 432

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PACIFIC DIVISION
Bendix Aviation Corporation
NORTH HOLLYWOOD, CALIF.

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Canadian — Computing Devices of Canada, P. O. Box 508, Ottawa 4

SEALTIGHT PIPE SHIELD

. . . The practical answer to PERMANENT PROTECTION against all ROCK DAMAGE!

Effective "holiday-free" pipe protection

Sealtight Pipe Shield provides an easily workable protective shield for pipes in every type of terrain or installation. It is the one completely effective and economical answer to "holiday-free" pipe shielding . . . eliminates the expense of dirt padding. Penetration tests show that even large rocks fail to rupture this material. Ideal for protecting pipe sections pulled across swamps . . . replaces ineffective, costly wooden slats or snow fence materials in shielding coated pipes at river crossings and under river clamps. Sealtight Pipe Shield is impervious to stress and strain of soil movements—unaffected by soil chemicals and moisture. Records of on the job tests prove Sealtight Pipe Shield far more effective and less costly than ditch padding installations.

EASILY APPLIED

Sealtight Pipe Shield is quickly and easily installed by untrained crews. The necessary straps, tools and seals are available and can be shipped as a complete package when desired.

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W.R. MEADOWS, inc.
11 KIMBALL ST. • ELGIN, ILLINOIS

NEW Pipeline Equipment

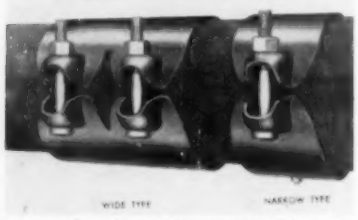
• machinery • supplies • services

For more information on items described here in brief, use the handy reply card and circle the corresponding numbers

Giant Orifice Fitting. Standing over 8 ft high and weighing 5 tons, Commercial Type CS is the largest orifice fitting ever built which can be operated by one man. Giant 30-in., 600-lb ASA fitting has a maximum operating capacity on a 1440-psi line of 1¼ billion cu ft of gas per day. Upper chamber swings out and orifice plate carrier is lowered on a nonrising stem to within easy reach of the operator. Due to chambered construction and lubricant sealed plug valve, the fitting may be serviced and the orifice plate changed under line pressure. *Commercial Iron Works.*

Circle number (81) on reply card.

Pressed Steel Economy Clamp. An improvement in design, together with a new manufacturing process, is announced for the Skinner-Seal pressed steel economy clamp. This clamp—for repairing rust holes and corrosion spots in pipelines—is now cold formed on a 500 ton press. It



has new heavily reinforced closed lug construction. These lugs are not welded to the clamp but formed from the material itself. Also, width of both clamps has been increased. Owing to the new lug design, clamp has been immeasurably strengthened. *M. B. Skinner Co.*

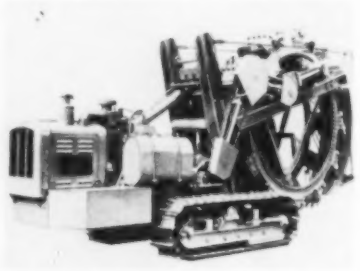
Circle number (82) on reply card.

Wheel-Type Ditcher. Barber-Greene Company has entered the wheel-type ditcher field with their Model 774 machine. A crawler mounted unit, it features a 5 ft 6 in. digging depth and widths adjustable in 1 in. increments from 18 to 30 in. Among the many innovations offered are widespread use of hydraulic power transmission; a unique, flexible connection between chassis and digging wheel; an elec-

tric, magnetically actuated overload release clutch and a reversible, hydraulically driven spoil conveyor. *Barber-Greene Company.*

Circle number (83) on reply card.

New Wheel-Type Trenchliner. A big capacity trenchliner, the Parsons 170, has been added to its line of wheel-type trenching machines by The Parsons Co. A



new feature on the 170 is a hydraulically driven conveyor that provides belt speeds up to 600 ft per min, yet works completely independent of the wheel speeds. As a result, it is possible to place spoil at a convenient distance from the trench wall when wheel speeds are slowed due to tough digging conditions. The 170 will produce from 12 in. to 25 ft of trench per min in a range of 30 digging speeds. Maximum digging depth is 5 ft 9 in. A selection of 7 cutting widths are available. *The Parsons Company, a division of Koehring Company.*

Circle number (84) on reply card.

Lubricating Spherical Roller Bearings. New advance in design of SKF Type "C" Spherical Roller Bearings provides 25 to 50 percent increased capacity and from two to three and one-half times more service life. Latest design improvement provides a positive method to obtain the more efficient "center" instead of "side" lubrication of the bearing, resulting in longer bearing life.

This is accomplished by means of a groove machined around the circumference of the bearing outer ring. Equally spaced holes drilled in the ring channel the lubricant from the groove to the center of the bearing. SKF Spherical Roller Bearings with this new method of lubrication can be used in any existing housing simply by drilling and tapping a new hole for the lubrication fitting in the center of the housing cap and plugging the original hole on the side. *SKF Industries, Inc.*

Circle number (85) on reply card.

Remote-Control System. New remote-control systems of telemetering that permit push-button operation of complex industrial processes hundreds of miles away have been demonstrated. Called Electro-Span, it is applicable in almost any situation where it is necessary to separate a human supervisor from the device or installation he is supervising. It eliminates the need for "castaway" maintenance men in isolated areas. Electro-Span can operate over existing communication facilities, such as telephone and telegraph lines, and VHF and microwave radio bands. It operates on the "digital" computing system, measuring or sensing in terms of numbers. *Bendix Aviation Corporation.*

Circle number (86) on reply card.

Electro-Mechanical System. Norwood Controls introduces its new ElectroSyn system to the natural gas, petroleum, and chemical processing industries. ElectroSyn is a non-electronic signal generator system for the measurement, indication, transmission and control of a variety of process variables: Pressure, differential pressure, flow, liquid level, temperature. High reliability combined with low maintenance and extreme flexibility are cited as the significant features which distinguish ElectroSyn from comparable existing systems. *Norwood Controls, Unit of Detroit Controls Corp.*

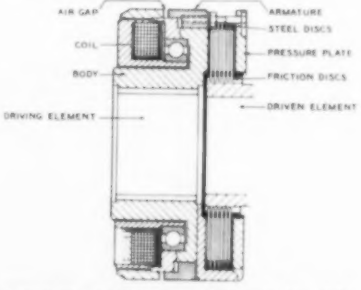
Circle number (87) on reply card.

New Controls for Ditcher. Gar Wood has equipped its Model 160 ladder-type ditcher with new hydraulic controls. Ditcher is now equipped with a hydraulic boom hoist for fast, positive positioning

of the boom, which is raised, lowered and held by an independent, package-type hydraulic control system. No friction boom clutch or brakes are required. Double-acting hydraulic cylinders provide full crowd for the boom. *Gar Wood Industries, Inc.*

Circle number (88) on reply card.

Magnetic Clutch. Features of this clutch include comparatively short axial, and small radial dimensions, complete isolation of the magnetic assembly from the integral mechanical parts, and compact, precision assembly of all component parts. It is furnished in stationary field or brush types and for either "wet" or "dry" operation, has a fast operating speed in both engagement and disengagement, and "decay time" and "residual drag" are re-



duced to an absolute minimum by isolation of the magnetic assembly from the clutch friction components. *Fawick Airflex Division, Fawick Corp.*

Circle number (89) on reply card.

M-15 Turning Rolls. New M-15 portable pipe rotators have been introduced by The Webb Corporation. These units, consisting of 1 variable speed powered rotator and 1 idler rotator, are used to rotate pipe and cylinderical shapes for flame cutting and welding operations. All

wheels on both power and idler units are rubber tired. Capacity of 1 power and 1 idler unit is 1500 lb total load. More than 1 idler can be used where long joints of pipe are to be welded or where load capacity needs to be increased. *Reed Equipment Division of The Webb Corporation.*

Circle number (90) on reply card.

New Oiltight Push Button. An illuminated oiltight push button, combining in one unit the functions of both a push button and an indicating light, has been announced. Device makes possible a saving of approximately 50 percent in panel control space.

Easily fitted in the same hole and mounting space as existing oiltight units, the device can be panel-mounted or back-mounted. *General Electric Company, General Purpose Control Department.*

Circle number (91) on reply card.

Medium-Sized Pipelayer. Availability of a new medium-sized pipelayer, designed to combine lifting power with sure stability, has been announced. Designated the Caterpillar No. 572 Pipelayer, new machine offers the pipelaying contractor 86,000 lb of lifting capacity at 4 ft overhang, and a wide 86-in. track gage, for dependable footing. Ground clearance of 19 in. assures maximum maneuverability in all types of terrain. To withstand the extreme stresses of heavy pipelayer work,

machine's design includes the integrated unit construction of the tractor chassis and pipelayer mechanism. Further weight carrying ability is provided by the extra heavy duty track rollers—6 on each side—having large diameter bearings and shafts. A large sprocket, designed especially for pipelayer work, has also been incorporated. Hydraulic track adjusters permit quick adjustment of track tension with a standard grease gun. *Caterpillar Tractor Co.*

Circle number (92) on reply card.

Plug-In Digital Systems. M-PACs transistorized logical circuits for asynchronous digital computing, data handling, logical analysis, simulation, and control systems are designed for d-c operation in the zero to 100-kilocycles range. Basic circuitry is derived from the Eccles-Jordan flip-flop and the multi-leg diode gate. They can be combined to perform all digital operations including arithmetic computation, storage, programming, and logical decision. Operations are determined by the manner in which the different basic packages are plugged in. Complete systems can be built up by interconnecting terminals in accordance with simple guide rules.

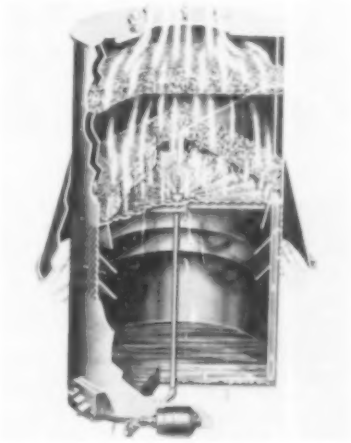
Basic packages include: Flip-flops, emitter followers, pulse amplifiers, diode gates and buffers, inverter amplifiers, one-shot multivibrators, variable frequency blocking oscillators, and crystal-controlled square-wave oscillators. Each M-PAC circuit is contained on a 2½-in. by 3¼-in. epoxy-glass printed-circuit card having a standard 12-pin connector and edged by a protective aluminum handle. *Computer Control Company, Inc.*

Circle number (93) on reply card.

Iron Powder Electrodes for Hard Facing. New iron powder hard facing electrodes are manufactured in 3 types. Wear-Arc 3 I.P. for build-up of worn parts, Wear-Arc 6 I.P.—an all position electrode with excellent resistance to abrasion, impact, and compression, Wear-Arc 12 I.P.—where extreme resistance to wear caused by heavy impact and abrasion is required. The weld metal is dense and free of porosity and provides an excellent fusion bond with the base metal or build-up material, to form a longer wearing deposit. *Alloy Rods Company.*

Circle number (94) on reply card.

Oil Bath Air Cleaner. Four major improvements have been revealed in American Air Filter's new low resistance Cycoil oil bath air cleaner for smooth flow applications. The latest model of the Type P low resistance-high efficiency cleaner offers a redesigned base for easier and less expensive installation; improved protec-



tion at the air intake against snow and water; greater bug protection; and redesigned and improved vari-flow valves. Thorough mixing of oil with intake air and positive draining from filter pads insure that 100 percent of the damaging dust is removed. These new features provide complete dust protection for supercharged engines and centrifugal compressors. *American Air Filter Company, Inc.*

Circle number (95) on reply card.

NEW Literature

New GM Hydrostarter. General Motors' new and improved Hydrostarter, which provides instant starts for diesel engines while eliminating the maintenance costs of batteries, cables, magnetos, air compressors, etc., is fully described in a new brochure. *Detroit Diesel Engine Division, General Motors Corporation.*

Circle number (96) on reply card.

Pushbutton Stations. Bulletin GEA-6544, an 8-page, 2-color publication, gives features, ordering information, dimension data, and application information on standard and heavy-duty push buttons. Photos show extent of each line and full page illustration shows features of heavy-duty pushbutton station. *General Electric Company.*

Circle number (97) on reply card.

Oil Storage Tanks Described. Standard sizes of welded steel oil storage tanks of Chicago Bridge & Iron are described in a newly revised brochure, "Oil Storage Tanks." Bulletin discusses types of roofs, welding, testing, maintenance and lists accessories furnished with each standard flat-bottom tank. Two tables give dimensions of standard sizes, in capacities from 500 to 268,000 bbl, for all-welded oil storage tanks. *Chicago Bridge & Iron Company.*

Circle number (98) on reply card.

Precision Unit Fire Detectors. A new 4-page illustrated brochure on unit fire detectors is now being offered. The detectors described are the hermetically-sealed Detect-A-Fire units, which operate on a unique rate-compensation principle. This principle causes the detector to actuate at its selected protection level regardless of how slowly or rapidly the surrounding temperature rises (below explosive conditions). By appropriate circuitry, the detector will actuate alarm and or extinguishing systems or other protective mechanisms. *Fenwal Incorporated.*

Circle number (99) on reply card.

Digital Computer. A 4-page illustrated report has been issued describing in detail how Bendix digital computer saved considerable engineering time and costs on highway earthmoving computations. The total cut and fill requirements of 230 cross sections of a 3-mile strip of parkway was solved in 45 minutes at a total cost of $38.80. *Bendix Computer Division, Bendix Aviation Corporation.*

Circle number (100) on reply card.

Gage Accessories. A new folder has been published describing accessories for various types of gages, dial thermometers and recorders. These accessories include attachments for protection of instrument internals against corrosive media and pulsations in pressures. Folder also shows the ring by which turret-case instruments can be panel-mounted, together with other tools and fittings used in instrument operations. *United States Gauge, Division of American Machine and Metals, Inc.*

Circle number (101) on reply card.

New Literature

Revised Tables. Revised size, capacity and weight tables necessitated by doubling of the maximum inlet pressure of Rockwell "120" sensitive regulators are included in a 4-page bulletin. The maximum inlet pressure of the "120" line has been increased from 5 to 10 psi by replacing the leather seal diaphragm with one made of special synthetic material.

In the newly revised bulletin, capacity tables make allowance for the fact that capacity is no longer limited to the amount of gas passed at a 1 psi inlet-outlet differential. It points out that differentials up to 10 psi may now be used provided the control tube is taken downstream. *Meter and Valve Division, Rockwell Manufacturing Company.*

Circle number (102) on reply card.

Galvanic Protection. The American Zinc Institute has published 2 reference manuals describing the use and application of zinc as a galvanic anode to protect iron and steel from corrosion. Publications deal with "Zinc as a Galvanic Anode Underground" and "Zinc as a Galvanic Anode Underwater."

"Zinc as a Galvanic Anode Underwater" describes the way zinc anodes protect marine craft, water storage tanks, H piling in sea water, traveling water screens, and spillway and lock gates against corrosion. Detailed step-by-step procedures are recommended for the most effective salt water applications. The text is amplified by tables, charts, and drawings. "Zinc as a Galvanic Anode Underground" discusses the theory and practice of zinc anode application in transmission pipelines, gas distribution systems, transmission line towers, ground rods, grounding cells, and domestic oil tanks. Specific recommendations indicate the most effective methods of applying zinc for the efficient protection of a wide variety of underground systems and structures made of steel. Tables, charts, and drawings illustrate the text. *American Zinc Institute, Inc.*

Circle number (103) on reply card.

Identification of Pipe Contents. Accidents caused by turning a wrong valve can be greatly reduced if pipes are identified by contents. How to identify any piping system by colors and lettering is clearly outlined in a new manual on pipe identification. The manual, entitled "How To Identify Your Piping System," tells the color to be used for each class of fluids and gases. It also reproduces the colors in actual tones, gives sizes and frequency of legends, and complete explanations of the dual methods recommended — by color and by legend. To further simplify the job, the manual shows the numbers of the coatings to be used with instructions for application for each different category of fluids or gases. *Rust-Oleum Corporation.*

Circle number (104) on reply card.

Motor Grader. Working advantages provided by the Allis-Chalmers Model Forty Five motor grader are covered in a new 16-page, 2-color catalog. Photographs and sketches aid readers to visualize details of the motor scraper's mechanical features and components. On-the-job photographs assist in telling the performance, operating, comfort and service simplicity of the Forty Five. Catalog also tells about attachments and accessories that add to the versatility of the unit, and includes its specifications. *Construction Machinery Division, Allis-Chalmers Manufacturing Company.*

Circle number (105) on reply card.

Revised Catalog. Anderson's 1957 catalog itemizes principal applications of its purifiers. New information has been included on improved types of internal purifiers for installation inside evaporators, boilers and other process vessels. Buying information is given on line type purifiers for installation as a compact unit on pipelines and receiver type scrubbers for handling extremely large slugs of liquid. A selection chart shows recommended sizes of line type Hi-eF purifiers at various steam flows on different pressures. Another new feature of the catalog is a section on new Quik-Flex thermostatic steam traps which are guaranteed freeze-proof on all petroleum and chemical applications. Anderson Super-Silvertop steam traps, Heat-Quik float traps and self-cleaning strainers are also cataloged. *The V. D. Anderson Company, division of International Basic Economy Corporation.*

Circle number (106) on reply card.

Zyglo and Zyglo-Pentrex. New booklet includes complete information on fluorescent penetrant materials and fluorescent penetrant testing. It makes clear the best selection of fluorescent penetrant materials and techniques for any individual testing use. Because Zyglo and Zyglo-Pentrex are widely used wherever nonmagnetic materials are manufactured or tested during overhaul, this booklet should be helpful in selecting and controlling the best test for each usage, and in selection of the test which will be the most economical in use, consistent with the requirements of the test to be performed. Booklet also contains a first in the use of the new fluorescent offset printing inks to represent the fluorescent indications of defects shown by Zyglo and Zyglo-Pentrex. Fluorescent indications have extreme advantages in speed and sensitivity when testing under Black Light. *Magnaflux Corporation.*

Circle number (107) on reply card.

High-Pressure Gas Regulator. A newly revised 8-page bulletin (No. 1024-6) describing the complete line of Rockwell high pressure regulators has been issued. New feature of the bulletin is a page of description, photos and drawings of Rockwell's high-pressure "141" regulator, which will withstand momentary overloads as high as 1000 psi on the outlet side without damage to the regulator. The Rockwell high-pressure "173" regulator is also described in greatly expanded detail. Complete capacity tables on the "141" and "173" are also included. *Meter and Valve Division, Rockwell Manufacturing Company.*

Circle number (108) on reply card.

Weather-Protected Motor. Features which contribute to the outdoor dependability of Allis-Chalmers weather-protected motors (Type FOD) in ratings from 250 to 900 hp are described in a new bulletin. Motors feature a sturdy steel frame, a removable pre-wound stator assembly, proved insulation, capsule-mounted split sleeve bearings, removable air ducts, and protective screens. *Allis-Chalmers Manufacturing Company.*

Circle number (109) on reply card.

Cathodic Protection Rectifiers. A brochure on Good-All rectifier units used in pipeline cathodic protection installations has been published. Book includes data for engineering, selection and application of units, and general information. *Good-All Electric Mfg. Co.*

Circle number (110) on reply card.

Fuel Injection System. A 12-page booklet, "Cummins PT Fuel Injection System," has been released. Printed in 4 colors, it shows cutaway views of the 4 PT fuel pump assemblies as well as the PT injector. A section is also devoted to optional governor arrangements. *Cummins Engine Company, Inc.*

Circle number (111) on reply card.

Rotating Machinery Protector. A device that protects rotating and reciprocating machinery by anticipating any malfunction is described in a 4-page bulletin. Known as the "Vibraswitch" malfunction detector, it will automatically shut down protected equipment or sound an alarm the instant normal operating vibration is exceeded. It is used for attended as well as unattended machinery, because many malfunctions progress too rapidly for attendants to take action. Bulletin covers different models of the vibration detector, as used in exposed, hazardous and protected locations. *Fielden Instrument Division, Robertshaw-Fulton Controls Company.*

Circle number (112) on reply card.

Trouble Shooting. If you are having trouble with a specific piece of equipment, what do you do? A bulletin released by Cummins Engine recommends that first you think before you act. Then ask yourself these questions: (1) What were the warning signs preceding the trouble? (2) What previous repair and maintenance work has been done? (3) Has similar trouble occurred before? The bulletin is entitled "Principles of Trouble Shooting for Cummins Diesels." It is designed to unfold so that it can be used as a wall chart. On the chart complaints are listed and probable causes are noted. Trouble shooting, according to the bulletin, is nothing more than an organized study of the problem and a planned method of procedure for the investigation and correction of the difficulty. The chart includes some of the most common complaints that may be encountered during the service life of a diesel engine. *Service Division of Cummins Engine Company, Inc.*

Circle number (113) on reply card.

Land Clearing Attachments. A 6-page bulletin describes special equipment for clearing land. Equipment is interchangeable with the blade on Caterpillar bulldozers. Specialities include a treedozer, stumper, rock rake, root rake, tree cutter, subtillage tool, brush rake, undergrowth chopper and other attachments. *Fleco Corporation.*

Circle number (114) on reply card.

Surface Active Agents. Publication of a major bulletin on the rapidly expanding field of surface active agents has been announced. Surface active agents are used in almost all industries today for wetting, dispersing, detergency, foaming and emulsification. The new bulletin gives technical data on the 7 types of "Aerosol" surface agents offered in commercial quantities by Cyanamid, including their use in basic formulations, data for testing effectiveness and information on storage and handling.

Information on how surface active agents are used in the manufacture of many specialty products is also included as suggestive of the uses to which the agents may be put. *Manufacturers Chemicals Department, American Cyanamid Company.*

Circle number (115) on reply card.

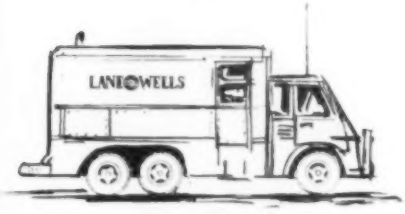
Complete Perforating Service

bullet or shaped-charge

LANE-WELLS GETS DEEPER PENETRATION

Yes, when you use Lane-Wells perforating service you can get maximum penetration in both bullet and shaped-charge perforating . . .

...BECAUSE



Because Lane-Wells 4 inch E-Gun blasts deeper than any 4 inch bullet gun available on the market today—25% deeper than its closest competitor.*

...BECAUSE

Because Lane-Wells 4 inch Karrotfree Koneshot ® blasts deeper than any 4 inch shaped-charge gun available on the market today—shoots 12.3% deeper than its closest competitor.*

* From the published results of independently conducted tests.

Your LANE WELLS man has the full story ...ask him to give you the facts

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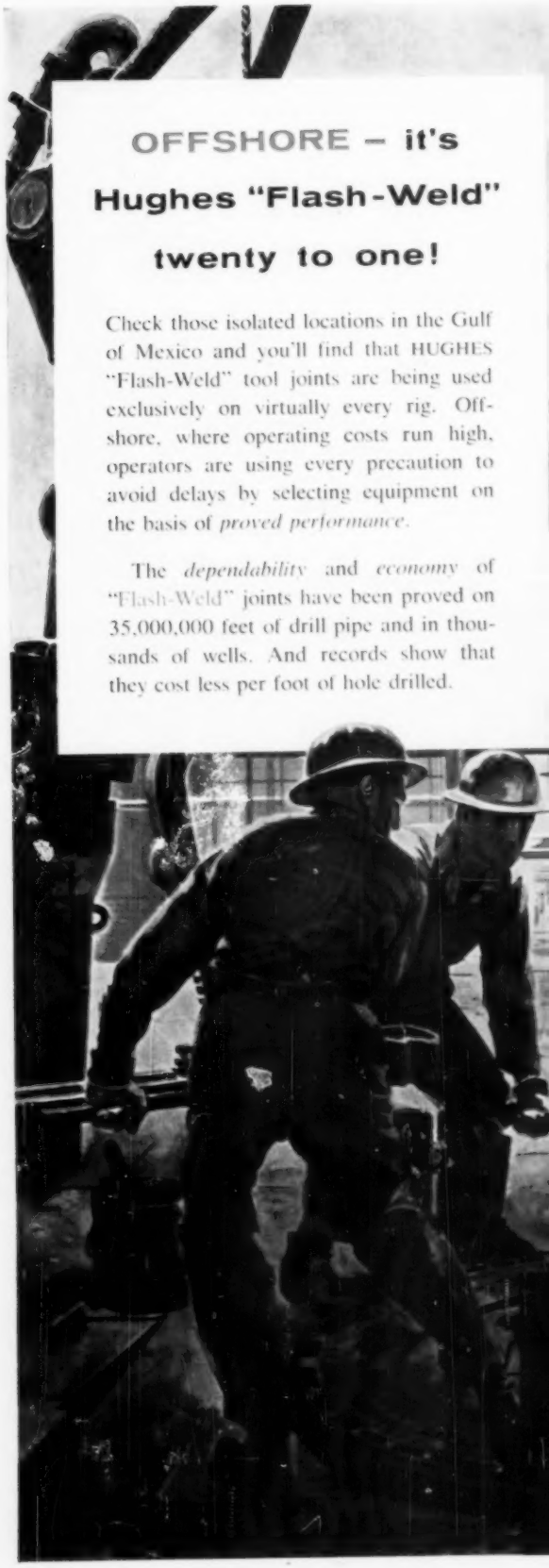

OFFSHORE – it's Hughes "Flash-Weld" twenty to one!

Check those isolated locations in the Gulf of Mexico and you'll find that HUGHES "Flash-Weld" tool joints are being used exclusively on virtually every rig. Offshore, where operating costs run high, operators are using every precaution to avoid delays by selecting equipment on the basis of *proved performance*.

The *dependability* and *economy* of "Flash-Weld" joints have been proved on 35,000,000 feet of drill pipe and in thousands of wells. And records show that they cost less per foot of hole drilled.

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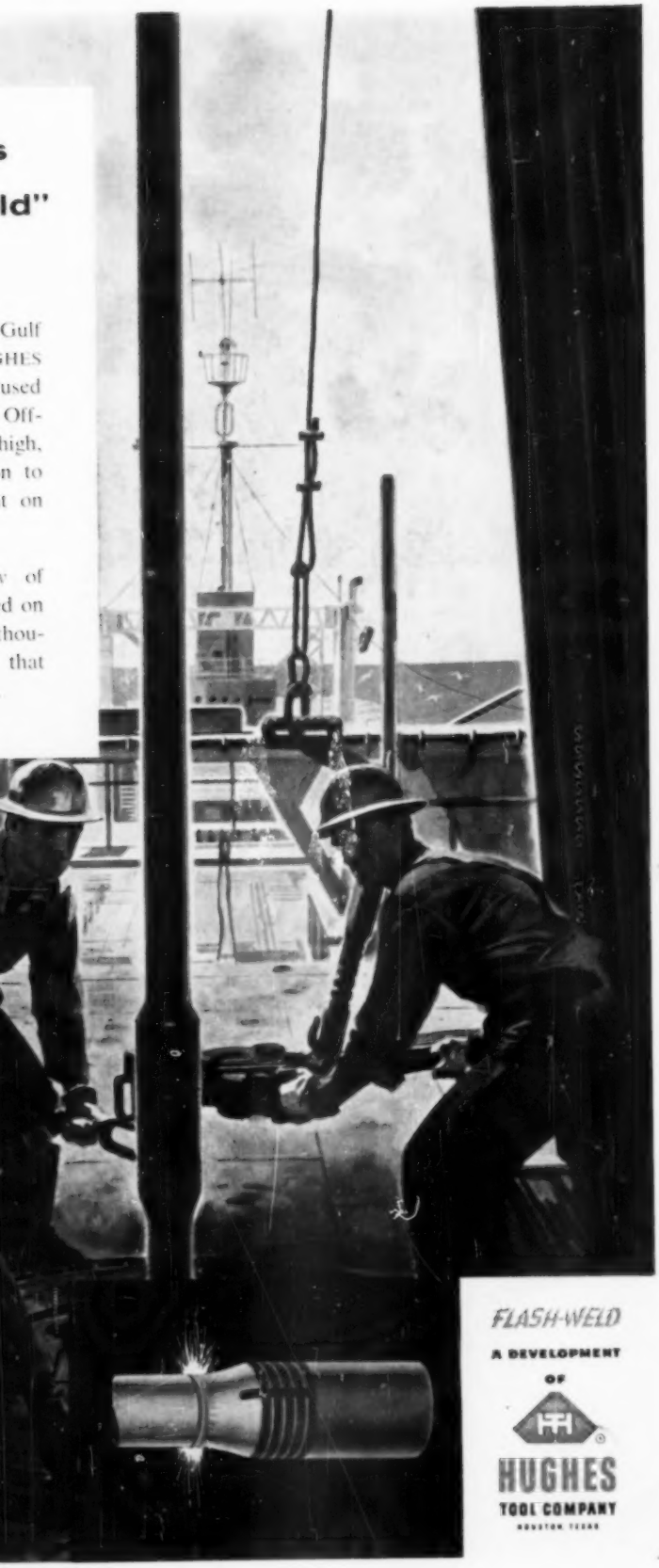

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